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WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY. VOLUME V. SU--ETC(U)

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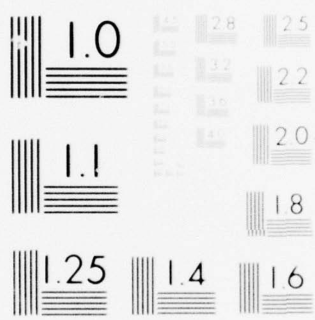
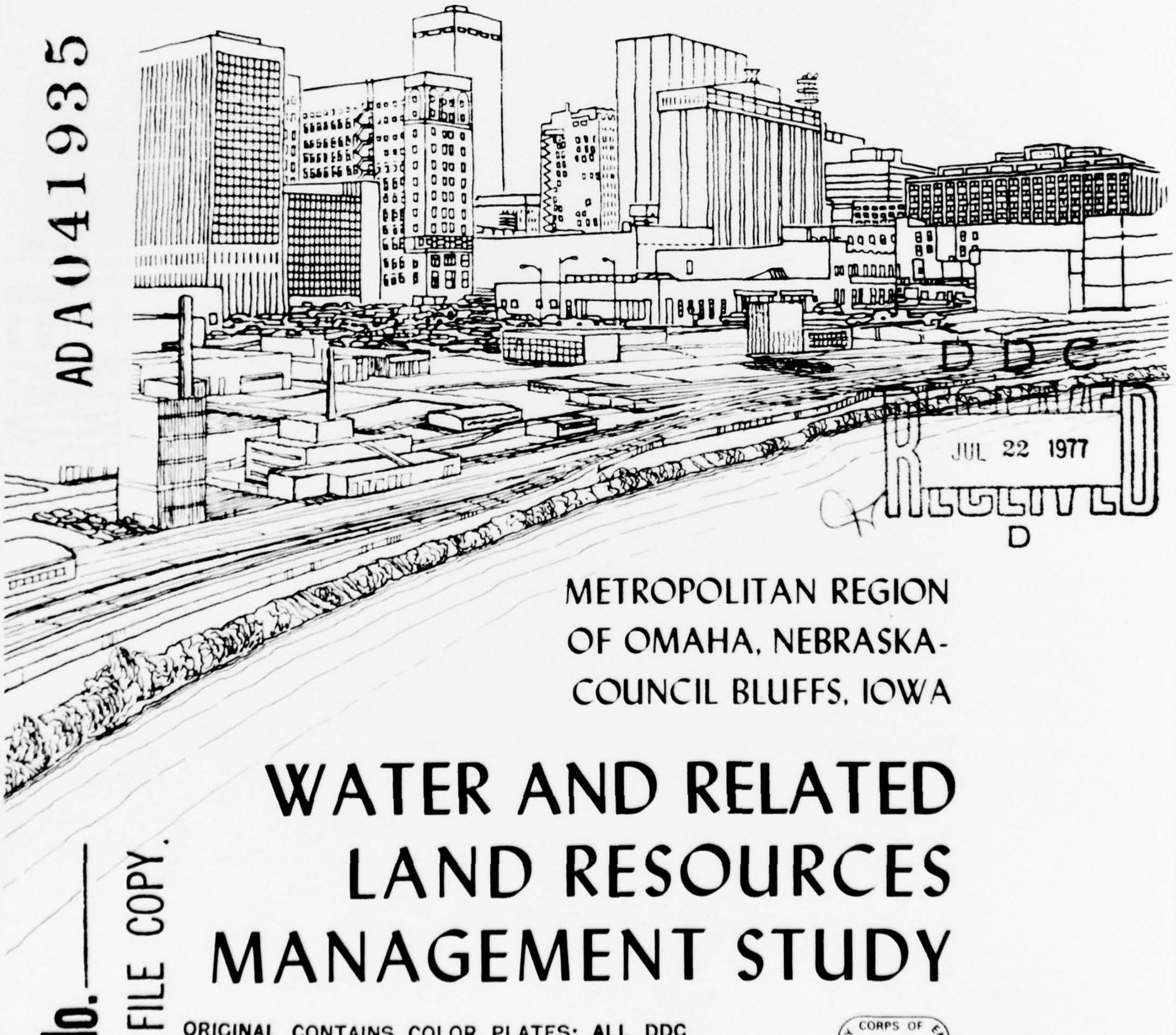


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

VOLUME V
SUPPORTING TECHNICAL REPORTS APPENDIX

ANNEX H - REGIONAL WASTEWATER MANAGEMENT

REVIEW REPORT ON THE MISSOURI RIVER AND TRIBUTARIES



METROPOLITAN REGION
OF OMAHA, NEBRASKA-
COUNCIL BLUFFS, IOWA

WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

JUNE 1975

CORPS OF ENGINEERS · U.S. ARMY · BICENTENNIAL · 1775-1975

34

(6) Water and Related Land Resources
Management Study.
Volume V. Supporting Technical Reports
Appendix.
Annex H. Regional Wastewater Management.

REGIONAL WASTEWATER
MANAGEMENT STUDY
PHASE II
Omaha-Council Bluffs

(11) Jun 75

(12) 246 p.

March, 1975

Prepared for Omaha District
Corps of Engineers
Contract DACW45-74-C-0117

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REPRODUCTIONS WILL BE IN BLACK AND WHITE.

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RATE INVESTIGATIONS
SANITARY LABORATORIES

PLEASE ADDRESS REPLY TO
CLEVELAND, OHIO 44114

March 15, 1975

Mr. Charles F. Thomas, Chief
Planning Division
Omaha District, Corps of Engineers
6014 U.S. Post Office and Court House
Omaha, Nebraska 68102

Dear Mr. Thomas:

We are pleased to submit herewith our Final Draft Report "Regional Wastewater Management Study for Omaha-Council Bluffs, Phase II", in accordance with the terms of our Contract DACW45-74-C-0117.

This report contains the results of the wastewater management study on the seven county area surrounding Omaha, Nebraska and Council Bluffs, Iowa. The technical data involving the various Wastewater Management Alternatives is provided for use in the Urban Study of the area.

We will be happy to meet with you to discuss aspects of the study at your convenience.

Very truly yours,

HAVENS AND EMERSON, LTD.

G. D. Simpson

George D. Simpson

NEH:kam

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A. INTRODUCTION

A. INTRODUCTION

STUDY BACKGROUND

Goals and Objectives

The objective of the overall Urban Study is to aid in developing water resources and related land areas so as to enhance the quality of urban life. To do this, single purpose studies are being undertaken dealing with various water sources and uses; wastewater, water supply, water recreation and flood control. These single purpose studies will then be linked to aid in developing a water resource management program for the urban region. This study involves the wastewater management portion of the Urban Study for the metropolitan Omaha-Council Bluffs area.

Wastewater Management Study

The objective of the wastewater management study is to develop wastewater systems for the area which will satisfy best the various needs in the Omaha-Council Bluffs region.

The sources of wastewater include all man-made wastewater including municipal and industrial discharges, as well as urban and agricultural runoff from storms.

The process of developing alternative plans for water resource management must consider many factors. These factors are defined in Sections 201 and 208 of Public Law 92-500. The factors are listed below with reference to the primary section of the Law which specifies the factor.

Develop areawide management - Sec. 201 (c)

Integrate wastewater systems with land use patterns - Sec. 201 (f)

Consider all available technologies - Sec. 201 (b)

Consider all wastewater sources - Sec. 201 (c)

Consider environmental and social impacts - Sec. 201 (b)(2)(E)

Following is a brief description of the relationship of these factors to the wastewater management study.

Areawide management - This study considers three study areas; the 100 mile radius for land treatment potential, the seven county area for inventory and analysis, and the urban area for more detailed analysis. (See Plate I).

Wastewater and Land Use - The Corps has proposed four possible growth concepts with their associated land use patterns for the urban area, which are considered in the study.

Technology - Both high level conventional treatment and land application treatment systems are considered.

Wastewater Sources - The study considers municipal sources; industrial sources and stormwater runoff sources. The runoff sources include urban runoff, combined sewer overflows and agricultural runoff.

Impact Assessment - The impacts of the components of each plan are inventoried and a method of evaluation proposed. The major evaluation of the effects of these impacts will be performed by the Omaha District, Corps of Engineers.

Report Format

The Wastewater Management Study was performed in two phases. Phase I included an inventory, evaluation and projection of municipal wastewater sources including domestic, industrial and stormwater runoff. An initial set of alternatives was developed along with preliminary estimates of costs and impacts on the study area.

The second phase of the study provides for further analyses of the initial alternatives and the selection of a limited number of alternatives for final presentation. The Phase I report was submitted in October, 1974, and included eight conceptual alternatives with several subalternatives. The subalternatives included three wastewater treatment levels, two stormwater treatment levels, four growth concepts and three storm sizes.

This volume contains the results of the Phase II study. The report consists of five sections:

Phase I Summary

Phase II Analysis

Phase II Alternatives

Specific Planning Considerations

Conclusions and Recommendations

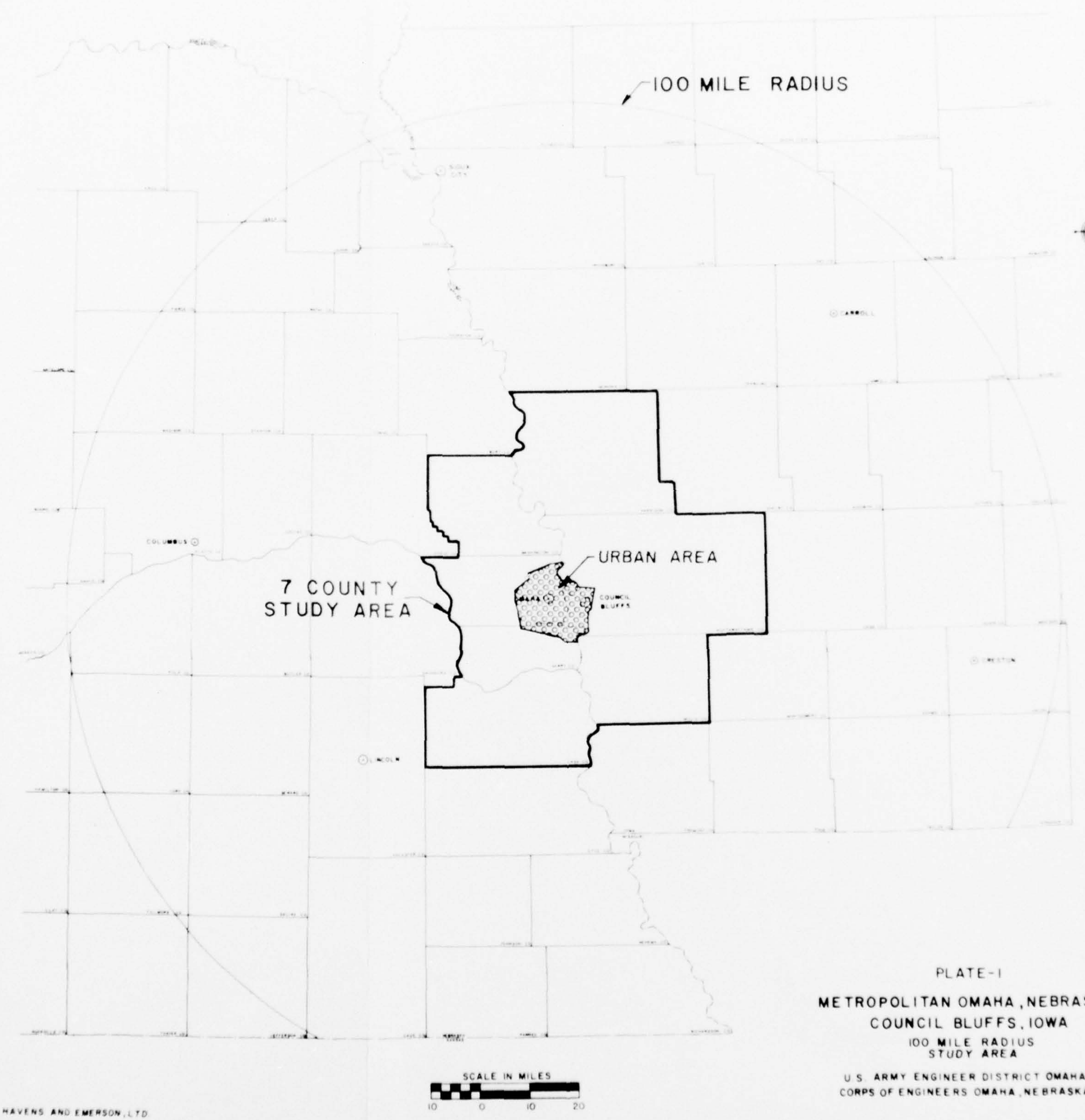

PLATE-1

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
100 MILE RADIUS
STUDY AREA

U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

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B. PHASE I SUMMARY

STUDY AREA

General Description

The study area includes the seven counties around Omaha, Nebraska and Council Bluffs, Iowa, which are Cass, Douglas, Sarpy, and Washington in Nebraska, and Harrison, Mills and Pottawattamie in Iowa. The Missouri River bisects the area in a North-South direction and the Platte River discharges drainage from Nebraska just south of Omaha.

The significant topographic features consist of the Missouri and Platte River valleys surrounded by steep bluffs, rolling hills and flat plains to the west. The valley areas are flat with river deposited soils and high groundwater tables. The bluffs are rugged and irregular with exposed bedrock materials in some areas. The rolling hills are primarily glacial till which is eroded and mantled with loess. The plains area of Saunders, Butler and Seward counties is very flat land laying above the valley. The bedrock formations consisting of subsurface sandstones and shales with deeper limestones are generally greater than 20 feet in depth except in the bluffs area where outcropping exists.

The average monthly temperatures range from below 20°F in the winter to above 80°F in the summer. Extremes of -32°F to 114°F have occurred. The urban rainfall is about 28 inches per year, varying from 0.8-4.5 inches per month, with a decrease toward the western areas and an increase toward the eastern. Class A Pan

evaporation in Omaha is about 55-60 inches increasing to the west and decreasing to the east.

Population

Table 1 shows the population changes which have occurred in the past decade for the seven counties in the study area. Table 2 shows the 1995 and 2020 population projections for the principal sanitary districts in the study area. The move from the rural areas and the urbanization of Sarpy County is significant. The entire area is generally showing an increase in population although the rate is lower in the past decade than in the 50's.

Land Use

Drainage areas, illustrated in Plate 2, were established in areas that are potentially affected by the future growth of the metropolitan area and also in areas that have an effect on the proposed Papillion reservoir projects. The total acreages and the present land use for these drainage areas are presented in Table 3. This table provides information useful in evaluating the relative magnitude of land usage, including total acreage and a breakdown of residential, industrial and commercial, feedlots, cropland, other rural land, and open/public land uses.

TABLE 1

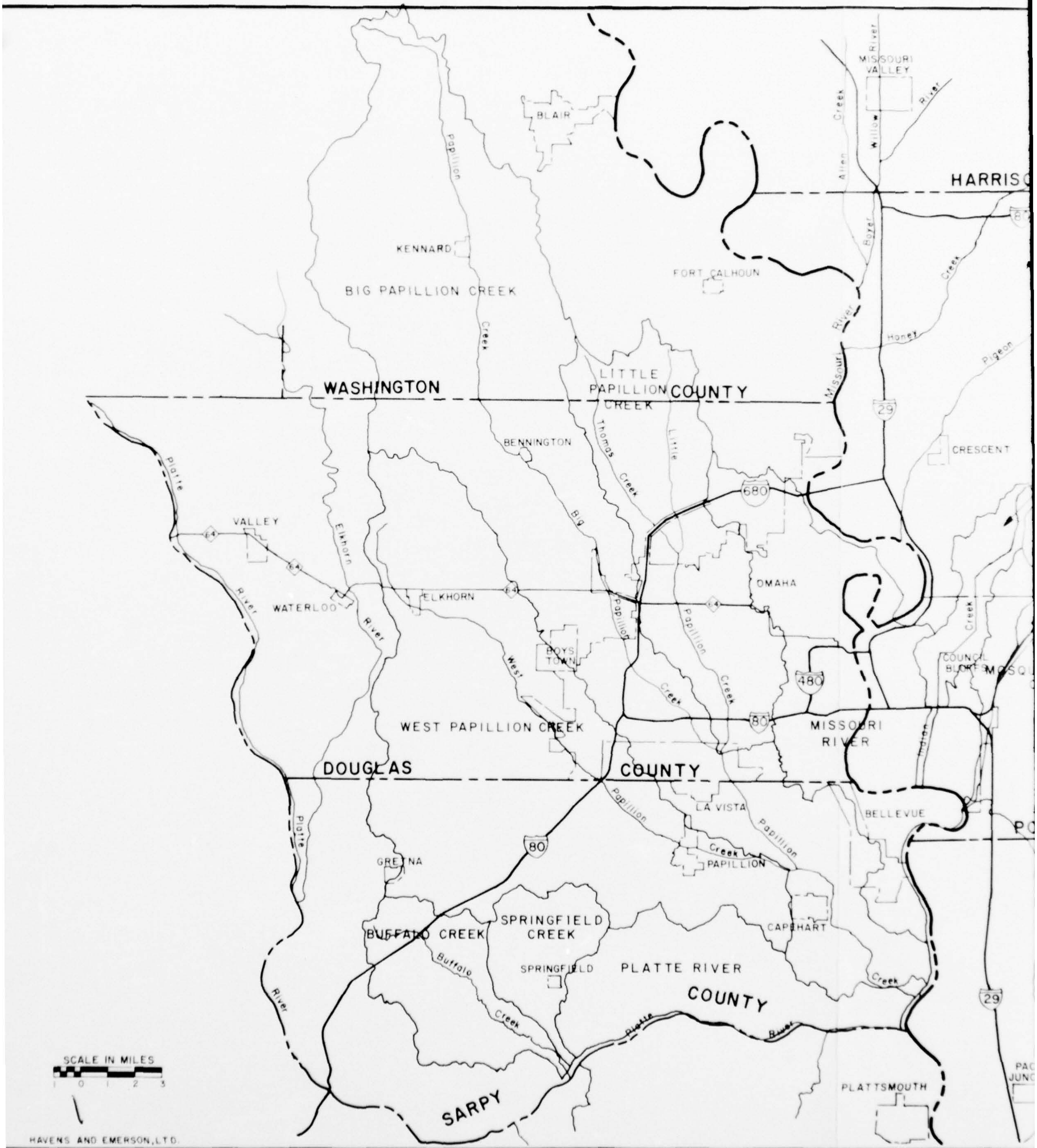
7 COUNTY POPULATION SUMMARY

County	1960 Population			1970 Population			1960-1970 Percent Change of	
	Total	Urban	Rural	Total	Urban	Rural	Urban	Rural
Cass	17,821	6,244	11,577	18,076	6,371	11,705	+2.0	+1.1
Douglas	343,490	323,736	19,754	389,455	373,160	16,295	+15.3	-17.5
Harrison	17,600	3,567	14,033	16,240	3,519	12,721	-1.4	-9.4
Mills	13,050	4,783	8,267	11,832	4,195	7,411	-12.3	-10.4
Pottawattamie	83,102	60,547	22,555	86,991	64,847	22,144	+7.1	-1.8
Sarpy	31,281	14,429	16,852	63,696	53,769	9,927	+272.6	-41.1
Washington	12,103	4,931	7,172	13,310	6,106	7,204	+23.8	+0.4
Study Area Totals	518,447	418,237	100,210	599,374	511,967	87,407	+22.4	-12.8

TABLE 2

PROJECTED POPULATIONS (BY GROWTH CONCEPT)
FOR SANITARY DISTRICTS IN STUDY AREA

	1995 Population				2020 Population			
Sanitary District	Concept A	Concept B	Concept C	Concept D	Concept A	Concept B	Concept C	Concept D
Major Urban:								
Missouri River	179,897	201,569	221,075	192,917	209,586	255,498	274,675	209,308
Council Bluffs	73,420	74,681	74,111	65,385	89,353	84,749	89,532	91,113
Papillion	514,377	376,274	472,508	511,356	610,106	424,742	544,838	609,588
All Minor Urban	57,589	172,759	57,589	55,625	70,703	214,759	70,703	69,739
All Non-Urban	26,999	26,999	26,999	26,999	29,304	29,304	29,304	29,304
Totals	852,282	852,282	852,282	852,282	1,009,052	1,009,052	1,009,052	1,009,052


MISSOURI VALLEY
BLAIR
HARRISO
KENNARD
FORT CALHOUN
BIG PAPILLION CREEK
Papillion
Creek
Allen Creek
Willow River
Boyer River
Missouri River
Honey Creek
Pigeon Creek
WASHINGTON COUNTY
LITTLE PAPILLION CREEK
Thomas Creek
Little
BENNINGTON
CRESCENT
Platte
680
Big Papillion
VALLEY
64
WATERLOO
Elkhorn River
ELKHORN
OMAHA
BOYS TOWN
West
COUNCIL BLUFFS
480
80
WEST PAPILLION CREEK
MISSOURI RIVER
Indian Creek
DOUGLAS COUNTY
LA VISTA
BELLEVUE
PO
Platte
GRETNA
Papillion Creek
PAPILLION
BUFFALO CREEK
SPRINGFIELD CREEK
CAPEHART
Buffalo Creek
SPRINGFIELD
PLATTE RIVER COUNTY
Creek
29
River
Platte River
SCALE IN MILES
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PAC JUNC
PLATTSMOUTH
SARPY
HAVENS AND EMERSON, LTD.

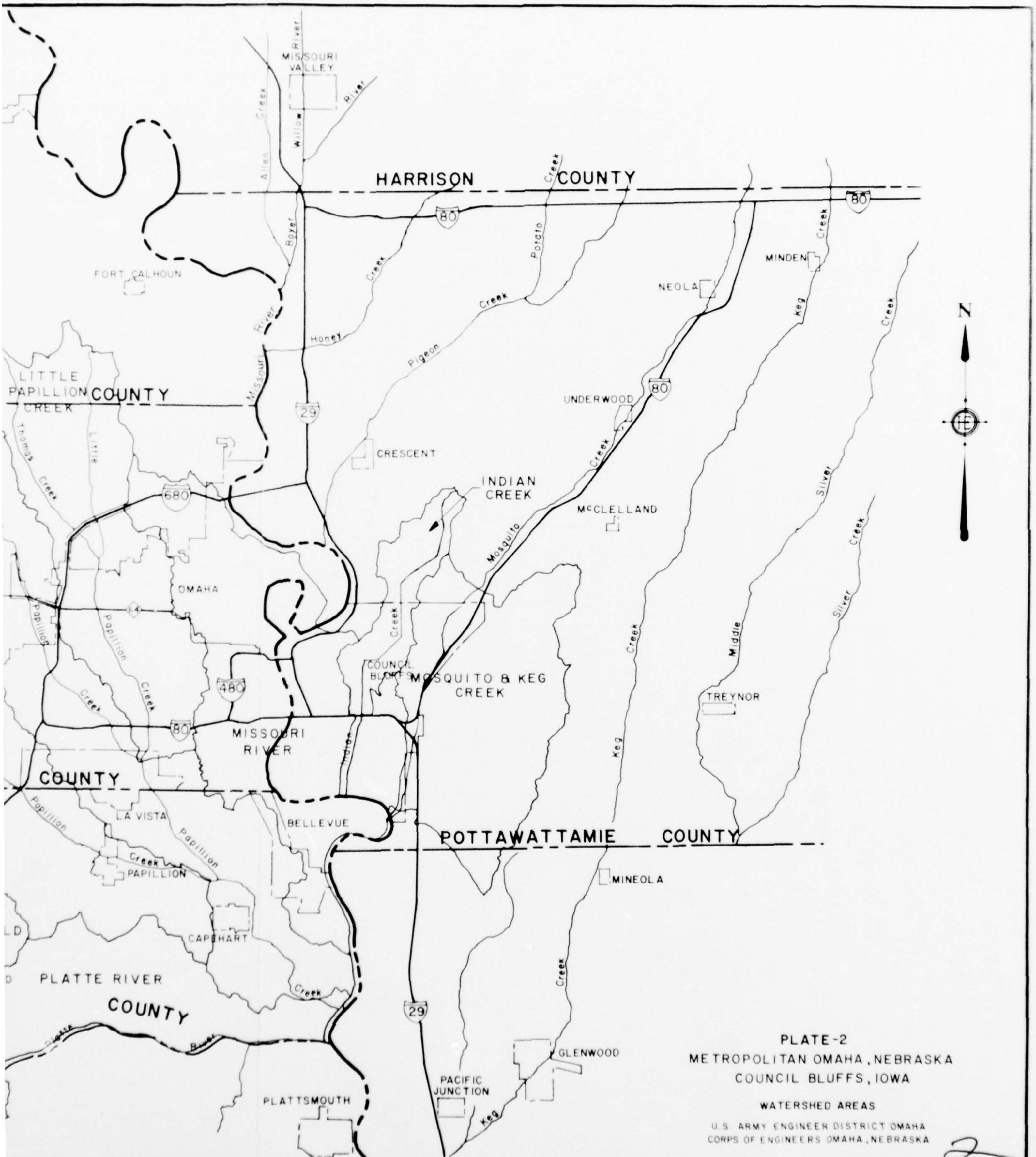


PLATE-2
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

WATERSHED AREAS

U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

TABLE 3
SUMMARY OF EXISTING LAND USE (ACRES)

Drainage Area	Total Area	Residential	Industrial & Commercial	Feedlots	Cropland	Other Rural	Open/Public
Big Papillion Creek	127,492	13,846	4,448	1,577	56,455	46,172	4,994
Buffalo Creek	17,137	--	--	277	11,802	5,058	--
Indian Creek	8,523	2,186	545	--	1,622	4,170	--
Little Papillion Creek	38,808	13,750	1,322	--	11,977	8,323	2,936
Missouri River (Iowa)	14,405	1,556	569	--	3,077	7,908	1,295
Missouri River (Neb.)	32,968	13,970	4,956	--	--	8,117	5,925
Mosquito & Keg Creek	34,596	1,343	--	--	14,628	15,612	3,013
Platte River	24,366	--	--	44	15,323	8,999	--
Springfield Creek	10,684	132	7	85	7,740	2,720	--
West Papillion Creek	86,810	2,961	2,979	277	56,952	21,909	1,732
TOTAL	395,789	49,744	15,326	2,260	179,576	128,988	19,895

WASTEWATER SOURCES

Municipal Sources

Plate 3 and Table 4 show the current wastewater facilities inventoried for the area. About 100 facilities were identified, and detailed in the Phase I report, with a capacity of greater than 5,000 gallons per day. Many of these facilities are currently scheduled to be placed into regional systems via sewer extensions.

Table 5 lists the municipal wastewater treatment plants of capacity larger than 5,000 gallons per day, which were individually considered in this study. The municipal plants have been grouped in the following categories: major urban, minor urban, and non-urban. The major urban plants are the largest wastewater treatment plants and therefore have the greatest effect on the Wastewater Management Study. The minor urban plants include those of outlying communities which are potentially affected by the future growth of the metropolitan area. The non-urban plants include outlying communities which will probably not be affected by the growth of the metropolitan area.

Industrial Sources

The industrial characteristics of the study area are detailed in Attachment B, Volume III, of the Phase I report. The major industrial classifications considered included:

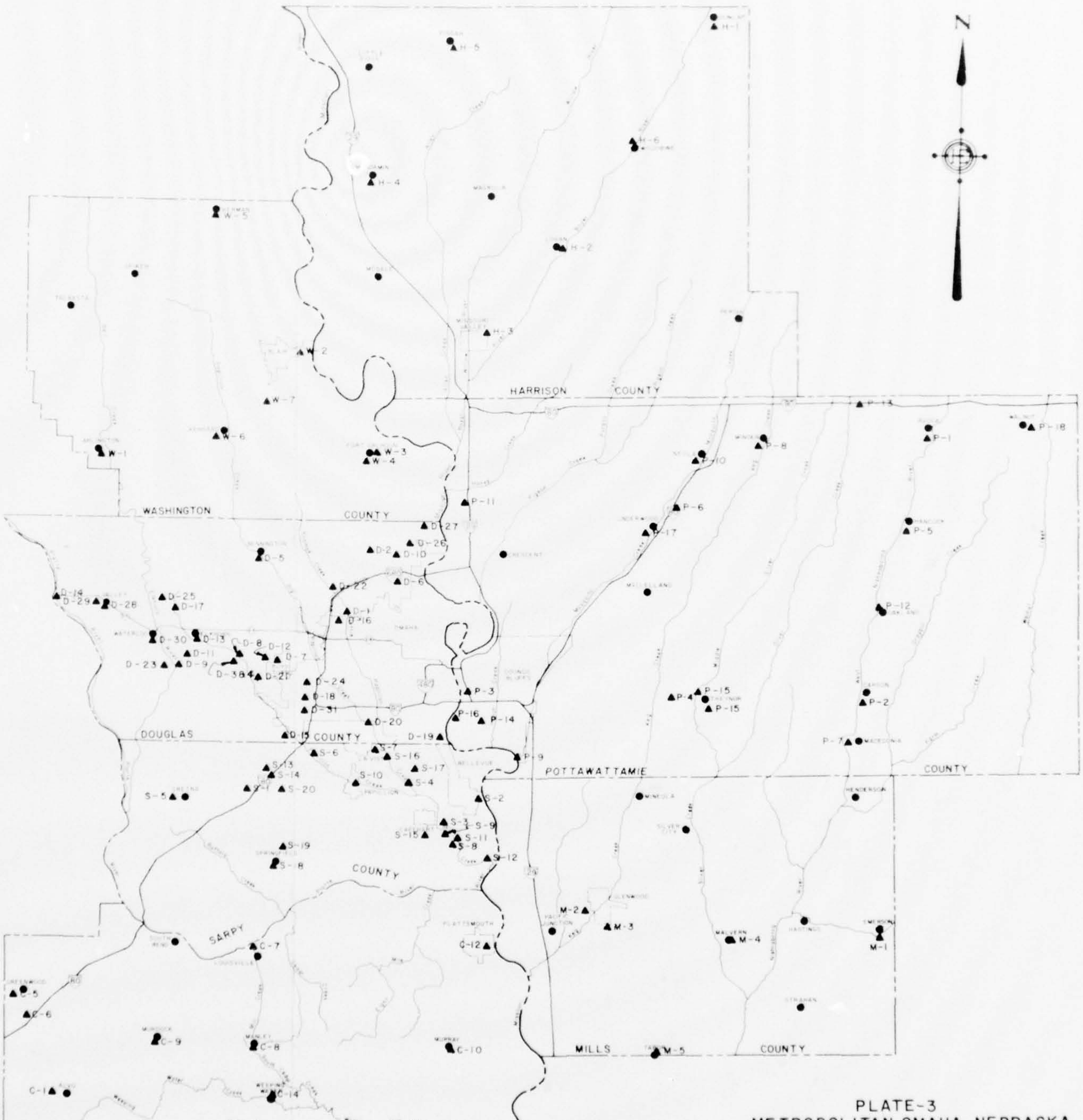


PLATE-3
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

EXISTING MUNICIPAL
WASTEWATER TREATMENT PLANT

U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

TABLE 4

CURRENT MUNICIPAL WASTEWATER FACILITIES

Ref. No.	Treatment Plant	Design Flow (mgd)
Cass County, Nebraska		
C1	Alvo	0.012
C2	Avoca	0.025
C3	Eagle	0.040
C4	Elmwood	0.050
C5	Greenwood	0.028
C6	Greenwood (Sid #2)	0.009
C7	Louisville	0.20
C8	Manley	0.013
C9	Murdock	0.017
C10	Murray	0.04
C11	Nehawka	0.025
C12	Plattsmouth	0.70
C13	Union	0.037
C14	Weeping Water	0.20
Sarpy County, Nebraska		
S1	Antilles Corp. (Sid #51)	N.D.
S2	Bellevue #1	0.90
S3	Bellevue #2	1.0 Sec. 2.0 Prim.
S4	Blue Ridge (Sid #14)	0.062
S5	Gretna	0.250
S6	Jacobson	1.5
S7	La Vista	0.50
S8	Normandy Hills #67	N.D.
S9	Offut A.F.B.	1.00
S10	Offut A.F.B. Lab	0.085
S11	Papillion	0.500
S12	Papillion Creek Plant	50
S13	Sapp Brothers Lagoon	0.024
S14	Sid #52	N.D.
S15	Southdale (Sid #25)	0.032
S16	Southern Park (Sid #83)	0.120
S17	Southern View (Sid #20)	0.065
S18	Springfield	0.059
S19	School District #46	0.007
S20	Westmont (Sid #23)	0.01
Douglas County, Nebraska		
D1	AAA Mobile Homes	N.D.
D2	AF Radar Station	N.D.
D3	Atkins Mobil Homes	0.018
D4	Atkins New Plant	N.D.
D5	Bennington	0.100
D6	Boniwell Estates	0.007
D7	Boys Town	0.200
D8	Carat Homes	0.015
D9	Chapel Hill (Sid #57)	0.067
D10	County Squire (Sid #135)	0.007
D11	Crest Mobile Homes	0.050
D12	Eldorado (Sid # 206)	0.085
D13	Elkhorn	0.085
D14	Ginger Cove (Sid #196)	0.012
D15	Holling Heights	1.250
D16	Knolls (Sid #229)	N.D.
D17	Mt. Michael & Benedictine High School	0.025
D18	Oak Hills	0.21
D19	Omaha-Missouri	72
D20	Omaha-Papillion	26
D21	Pacific Heights (Sid #126)	0.024
D22	Peaceful Valley Mobile Homes	N.D.
D23	Riverside Lake	0.01
D24	Signal Hill (Sid #124)	0.008
D25	St. John Seminary	N.D.
D26	Twilight Hills (Sid #128)	0.050
D27	Uta Halee Omaha Home For Girls	0.01
D28	Valley	0.30
D29	Valmont Industries	0.014
D30	Waterloo	0.075
D31	Westwood (Sid #31)	0.70
Washington County, Nebraska		
W1	Arlington	0.040
W2	Blair	0.008
W3	Ft. Calhoun	0.022
W4	Ft. Calhoun Power Plant	0.007
W5	Herman	0.036
W6	Kennard	0.052
W7	Rose Ann Mobile Home Park	0.027
Pottawattamie County, Iowa		
P1	Avoca	0.131
P2	Carson	0.049
P3	Council Bluffs	10.4
P4	Halverson Center for Education	N.D.
P5	Hancock	0.025
P6	I-80 Rest Area	0.120
P7	Macedonia	0.031
P8	Minden	0.045
P9	Mosquito	14.71
P10	Neola	0.100
P11	Nickerson Farms	0.006
P12	Oakland	0.150
P13	Skelly Station	0.003
P14	Trailer City	0.037
P15	Treynor	0.054
P16	Twin Cities Plaza	0.22
P17	Underwood	0.077
P18	Walnut	0.104
Harrison County, Iowa		
H1	Dunlap	N.D.
H2	Logan	N.D.
H3	Missouri Valley	N.D.
H4	Mondamin	N.D.
H5	Pisgah	N.D.
H6	Woodbine	N.D.
Mills County, Iowa		
M1	Emerson	N.D.
M2	Glenwood	N.D.
M3	Glenwood State Hospital	N.D.
M4	Malvern	N.D.
M5	Tabor	N.D.

N.D. - No Data Available

TABLE 5

MUNICIPAL WASTEWATER TREATMENT PLANTS

I MAJOR URBAN PLANTS

A. Nebraska
   1. Missouri River
   2. Papillion Creek

B. Iowa
   1. Mosquito Creek

II MINOR URBAN PLANTS

A. Douglas County, Nebraska
   1. Bennington
   2. Elkhorn
   3. Valley
   4. Boystown

B. Sarpy County, Nebraska
   1. Springfield
   2. Gretna
   3. Bellevue #1

C. Washington County, Nebraska
   1. Blair
   2. Fort Calhoun

D. Cass County, Nebraska
   1. Plattsmouth

E. Harrison County, Iowa
   1. Missouri Valley

F. Mills County, Iowa
   1. Glenwood

III NON URBAN (OUTLYING) PLANTS

A. Washington County, Nebraska
   1. Arlington
   2. Herman
   3. Kennard

B. Cass County, Nebraska
   1. Weeping Water
   2. Union
   3. Nehawka
   4. Murray
   5. Murdock
   6. Manley
   7. Louisville
   8. Greenwood
   9. Elmwood
   10. Eagle
   11. Avoca
   12. Alvo

C. Douglas County, Nebraska
   1. Waterloo

D. Harrison County, Iowa
   1. Logan
   2. Woodbine
   3. Mondamin
   4. Dunlap
   5. Pisgah

E. Pottawattamie County, Iowa
   1. Avoca
   2. Carson
   3. Hancock
   4. Macedonia
   5. Minden
   6. Neola
   7. Oakland
   8. Treynor
   9. Underwood
   10. Walnut

F. Mills County, Iowa
   1. Emerson
   2. Malvern
   3. Tabor

Standard Industrial Classification	Description
20	Food and Kindred Products
28	Chemicals
33	Primary Metals
34	Fabricated Metals
35	Machinery Except Electrical
36	Electrical Equipment and Supplies

About 60% of the total industrial process flow originate with SIC 20 and about 60% of this is treated at the OPCC Plant. About 70% of the BOD load, 86% of the TSS load and 45% of the oil and grease load also originate with the SIC 20 industries. Another significant industry classified in the SIC 28 group is dominated by one agrichemical company.

Industrial projections of flows and loads for each SIC group were developed for each of the sanitary districts and included in the development of the Regional Wastewater Management Plans.

STUDY PARAMETERS

Several variables are involved in any planning process. Four of these are discussed in this section as they apply to the Phase I Study.

Growth Concepts

The Corps of Engineers established a set of four possible patterns of urban growth for the area (Concept A, B, C & D). Concept A assumes a continuation of present land use and represents low density urban sprawl. Concept B involves a higher density growth consisting of contained growth for urban Omaha with separate, self-sustaining satellite cities separated by open space. Concept C also envisions a high density pattern for Omaha, but with expanding boundaries rather than separate satellite cities. Concept D allows low density development, as in Concept A, but presumes the development will occur as a secondary effect of the existing transportation routes. Appendix A contains the land use maps developed by the Corps of Engineers exhibiting these growth concepts.

Treatment Levels

Three effluent standards have been established in conjunction with the Corps of Engineers for wastewater treatment system discharges as shown in Table 6. The lowest level, Level 1, (secondary treatment) is fixed by EPA definition and is required by 1977. The highest level, Level 3, is the Corps of Engineers' interpretation of the Public Law 92-500 requirement for zero discharge. This

TABLE 6

SUMMARY OF EFFLUENT QUALITY FOR WASTEWATER TREATMENT GOALS

Treatment Goal	Level	BOD	SS	DO	NH3-N	Org N	NO_2 & NO_3 as N	Total P	Fecal Coliform	pH
WASTEWATER TREATMENT										
Secondary	1	30	30	N.A.	N.A.	N.A.	N.A.	N.A.	200/100ml	6-9
BPT - Water Quality	2	*	*	*	*	*	*	*	*	*
Zero Discharge	3	5	<5	N.A.	0.5	5	4	0.1	200/100m.	6-9
LAND TREATMENT										
Stream Discharge	2 & 3	*	*	*	*	*	*	*	*	*
Groundwater Discharge	2 & 3	**	**	**	**	**	**	**	**	**

*Limit determined by effect on stream of oxygen-demanding materials, nutrients, toxicity and fecal coliforms, with nitrification included in all cases.

**Drinking water standards for groundwater supply

N.A. - Not Applicable

All parameters are listed on a less than or equal basis.

level of treatment is required by 1985 with secondary treatment between 1977 and 1983. The intermediate level, Level 2, (BPT-Water Quality) presents a level of treatment which is based on the state water quality standards and an interpretation of best practical technology. This effluent level has been developed in Phase I by experience and knowledge of the area streams. Computer modeling of the stream is shown in Section C of this Phase II report.

In addition, two effluent standards have also been established for urban stormwater runoff discharges, and are shown in Table 7. Level 1 was established to provide a minimal degree of treatment by providing screening, sedimentation, and disinfection. Level 2 was established to provide a higher level of treatment to meet water quality standards and included the addition of microstraining to the Level 1 process stream. In the design and development of the regional wastewater management plans the Level 1 stormwater treatment facilities were used in conjunction with both Level 1 and Level 2 wastewater treatment. Level 2 stormwater was used with the Level 3 wastewater for the alternative plans.

Wastewater Treatment

In order to develop costs associated with the alternative plans, designs for the treatment plants were developed to respond to the prescribed effluent levels. The plants were categorized by size and effect: Major Urban, Minor Urban and Non-Urban, as previously defined in Table 5. The Major Urban plants received the most detail and were analyzed separately. A single design concept was used for each of the other categories which would provide

TABLE 7

SUMMARY OF TREATMENT GOALS FOR STORMWATER TREATMENT

STORMWATER TREATMENT	
Level 1	Screening, sedimentation, disinfection. Estimated 40% removal BOD; 70% removal SS; to 200/100 ml fecal coliforms. Full alternate.
Level 2	Treatment necessary to meet water quality standards in receiving streams, except that higher treatment may be required for some Papio tributaries to protect quality of impoundments. Full alternate.

a reliable facility given the general site and influent characteristics. Schematics and mass diagrams are presented in Appendix B for each design. A detailed design could involve a different treatment concept, but the processes chosen are representative of the cost ranges involved.

Physical-chemical treatment has been proposed in numerous studies as an alternative to biological treatment to attain the higher levels of treatment required by PL 92-500. For example, the Corps of Engineers' Survey Scope Studies for Chicago, Detroit, and Cleveland-Akron considered physical-chemical treatment to be comparable with advanced biological systems.

For the Omaha Urban Study, consideration was given to physical-chemical treatment processes but was not adopted for a full alternative for the following reasons:

1. The organic nature of the wastewater makes it highly amenable to a biological treatment process, at lower unit cost per pound of COD removed.
2. Current planning, design, and construction has been based on biological treatment systems and existing systems would require major changes to adopt a physical-chemical treatment process.
3. The scope of the Urban Study does not direct itself to the detailed design and cost considerations necessary for full evaluation of physical-chemical treatment at each plant in the study area. In particular cases, this question should be reviewed during the facilities planning process.

Major Urban Plants - The study area contains three major urban treatment plants. Each of these plants was considered separately with specific processing schemes developed with consideration given to the existing and/or under design unit processes. Table 8 summarizes the future wastewater quality and quantity characteristics for the various alternates. The following describes each plant with Appendix B, Figures 1-7 showing the schematics and mass diagrams.

Papillion Creek Plant - Primary treatment and complimentary sludge handling facilities have recently been bid for this 50 mgd plant. The proposed secondary level system[1] consists of trickling filtration with intermediate solids-liquid separation followed by activated sludge. Odor control requirements at this plant are extremely stringent; the primary clarifiers, for example, are to be enclosed as are the future trickling filters. In view of the need for close odor control, the proposed processing sequence incorporates the covered reactors associated with pure oxygen activated sludge treatment.

Missouri River Plant - The Missouri River Plant expansion is presently under detail design for a flow of 60 mgd. The proposed system[2] is adequate for Level 1 effluent standards.

Council Bluffs - Mosquito Creek Plant - This plant is presently nearing completion and is intended to phase out the old Council Bluffs Plant. It has been designed[3] for approximately 15 mgd under a presumed reduction of present industrial releases, and is

TABLE 8

MAJOR URBAN PLANTS - FLOW AND QUALITY CHARACTERISTICS

DESIGN QUALITY	Papillion Creek Plant: Plan I, II, VI, VIII	Papillion Creek Plant: Plan IV, V	Missouri River Plant: North Sewer	Missouri River Plant: South Sewer	Council Bluffs-Mosquito Creek Plant
RESIDENTIAL AND INDUSTRIAL - mg/l					
SS	450	480	505	590	600
VSS	380	410	430	505	500
BOD_5	420	460	485	570	580
COD	760	835	880	1,035	1,050
TKN	44	48	50	57	60
PO_4-P	9	8.5	8	7	8.5
ALK ($CaCO_3$)	225	225	225	225	225
Oil and Grease	110	150	180	260	245
WATER PLANT SLUDGE					
#/day per mgd	2,700(3)	2,900(4)	3,100(2)	-	4,050
DESIGN FLOWS					
1975 - mgd	25		36		8.4
1995 - Range, mgd	44-110		43-51		15-16
2020 - Range, mgd	72-160		60(1)		27-30

(1) 2020 Flow Distribution: North Sewer = 41 mgd, South Sewer = 19 mgd
(2) From Florence Water Supply
(3) From Platt
(4) Mixture of (2) and (3)

adequate for secondary levels.

Minor Urban Plants - Table 9 summarizes present and future conditions for the minor urban plants. Future planning predicts the addition of two more plants to the present dozen. Typically, growth patterns anticipate a forty to fifty percent flow increase over the twenty-five year time frame between 1995 and 2020. The influent wastewater quality reported in this table is indicative of what would be anticipated for these facilities without the presence of a major wet industry.

The minor urban plants do not have a dominant treatment technology although five of the twelve plants provide something less than Level 1 effluent quality. A process sequence for the minor urban plants was developed to make maximum use of existing equipment.

The design concept chosen for these plants is shown in Appendix B, Figures 8 and 9, and is developed around the rotating biological surface. Operational simplicity and lower power demands make this system attractive for plants of the size considered. Existing biological systems, such as trickling filtration or activated sludge, would replace the indicated first-stage rotating biological surface.

When design flows were less than 2 mgd, the waste biological sludge process sequence was modified to exclude flotation thickening and incorporate aerobic digestion. Anaerobic digester supernatant was returned to the aerobic digester. The aerobically and

TABLE 9

MINOR URBAN PLANT SUMMARY

Present Conditions

No.	12
Flow (mgd)	
Median	0.27
Range	0.06 to 0.88
Treatment Technology	
Act. Sl. and Modifications	3
Trick. Fil. and Modifications	4
Stabilization Ponds	2
Primary and Equiv.	3

Future Conditions

1995

No.	14
Flow (mgd)	
Median	1.1
Range	0.15 - 4.6

2020

Flow (mgd)	
Median	1.5
Range	0.28 - 6.7
Influent Quality (mg/l)	
SS	260
VSS	200
BOD_5	230
COD	450
TKN	35
PO_4-P	8.5
ALK($CaCO_3$)	225

Special

Water Plant Wastes:	
Blair	7800 #/Day
Bellevue	MG
Oil and Grease:	
Elkhorn	156 mg/l at 0.15 mgd = 195 lbs/day

and anaerobically digested sludges are applied to covered open-air sandbeds for dewatering. The dried sludge could be hauled to landfill or preferably used in the surrounding agricultural lands as a nutrient and organic additive.

Non-Urban Plants - Table 10 summarizes present and future conditions for the non-urban plants. Present conditions find 86 plants treating or designed for more than 5,000 gpd within the non-urban classification. By 1985, this number will be reduced to 56. Little growth is anticipated between the years of 1995 and 2020 and all plants were designed to the 2020 design condition. The assumed 2020 wastewater quality reflects the concentrated pollutant levels typically encountered in small wastewater flows.

Figures 10 and 11 of Appendix B schematically illustrate the proposed treatment schemes. The aeration ditch or "raceway" modification of the activated sludge system as originally proposed by Holland's A. Pasveer is used as the base process unit. This plug flow, complete mix aeration pattern is operationally simple and attractive from a power standpoint.

Waste sludge dewatering by sand beds with disposal by landfill or agricultural use is the system of choice for the small non-urban plants. The beds are designed to be covered but open to the air, thus allowing year round access and operation.

Table 10 shows that the stabilization pond is used extensively in the study area. Although this form of treatment is well established and involves a minimum of operation, it was not chosen as

TABLE 10

NON-URBAN PLANT SUMMARY

Present Conditions	Municipal	Private and/or Specialized Public Interest	
No.	34	52	
Flow (mgd)			
Median	0.06	0.08	
Range	0.014 to 0.15	0.008 to 26.0	
Treatment Technology		(Present)	(After 1985)
Act. Sl. and Modifications	7	17	7
Trick. Fil. and Modifications	3	8	2
Stabilization Ponds	20	26	13
Primary and Equiv.	3	3	0
None	1	0	0

Future Conditions

1995

	Municipal	Private and/or Specialized Public Interest
No.	34	22
Flow (mgd)		
Median	0.08	0.025
Range	0.014 to 0.19	0.10 to 0.050

2020

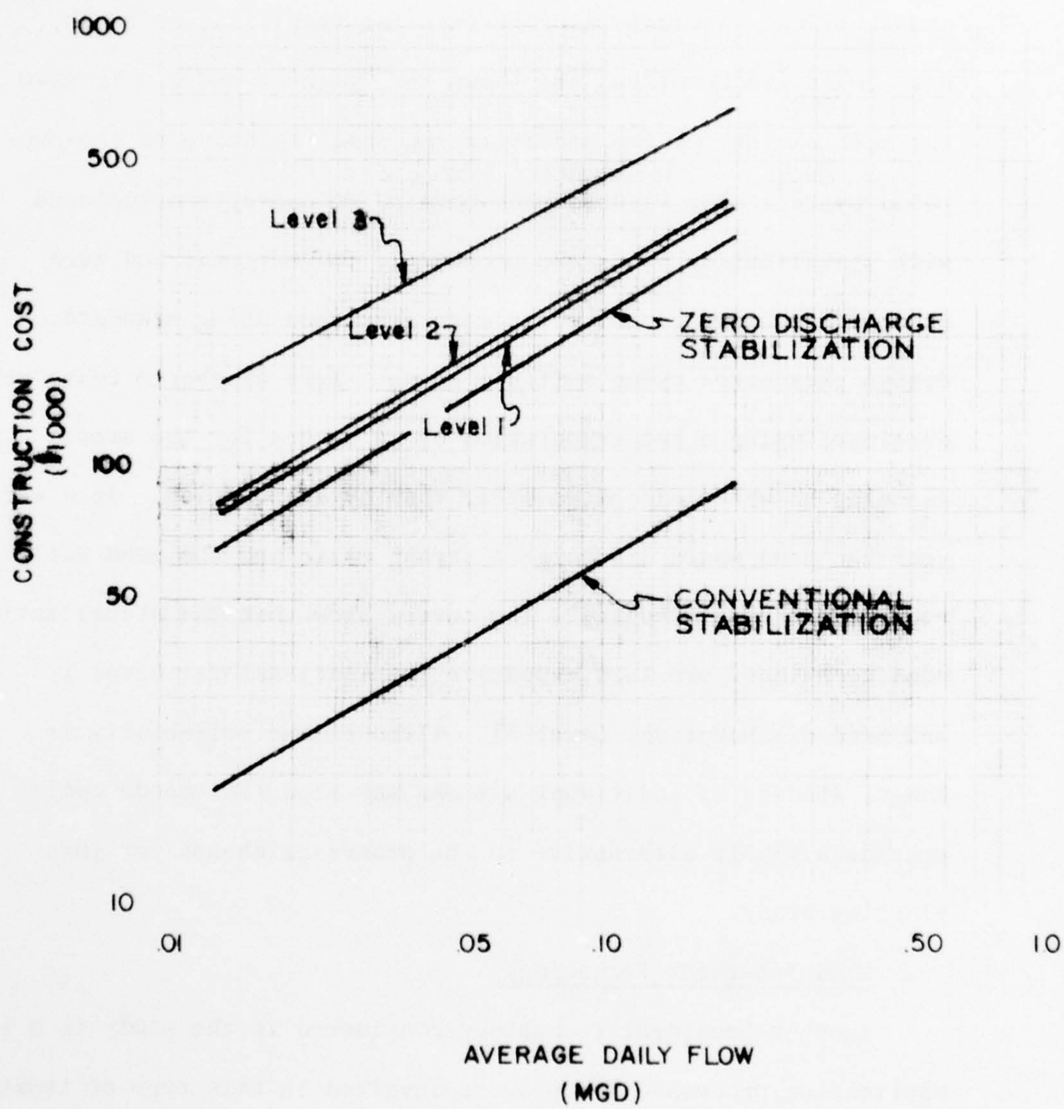
	Municipal	Private and/or Specialized Public Interest
Flow (mgd)		
Median	0.09	0.025
Range	0.014 to 0.23	0.10 to 0.050

Influent Quality (mg/l)	
SS	330
VSS	260
BOD_5	270
COD	530
TKN	41
PO_4-P	10.0
ALK ($CaCO_3$)	225

the base for this planning study. The aeration ditch was chosen because it is considered more reliable and more amenable to process additions for higher treatment levels. If local practice and experience indicate a preference for stabilization ponds, unit costs are developed and shown in Figures 1 and 2. To show the cost savings of the stabilization ponds relative to the proposed systems, the figures show both. Two concepts associated with stabilization ponds are presented; conventional and zero discharge. Conventional costs were developed using standard design parameters using multiple ponds. Zero discharge costs were developed using a net evaporation of 11 inches for the area, assuming no water discharge other than by evaporation. In a wet year the pond would discharge a strong waste and the pond will require periodic dredging. The curves show that the stabilization pond techniques are less expensive (conventional vs. Level 1 and zero discharge vs. Level 3). Although the reliability is lower, studies of individual systems may show that ponds could provide a viable alternative to the processes chosen for this planning study.

Land Treatment Technology

Another treatment technology considered in the study is a land application process. The process involved in this type of treatment includes a pretreatment step producing a secondary quality effluent, followed by storage and application of the pretreated effluent to croplands for effluent polishing and as a source of irrigation water. The land area can be underdrained with discharge to a local stream or the treated effluent can be allowed to



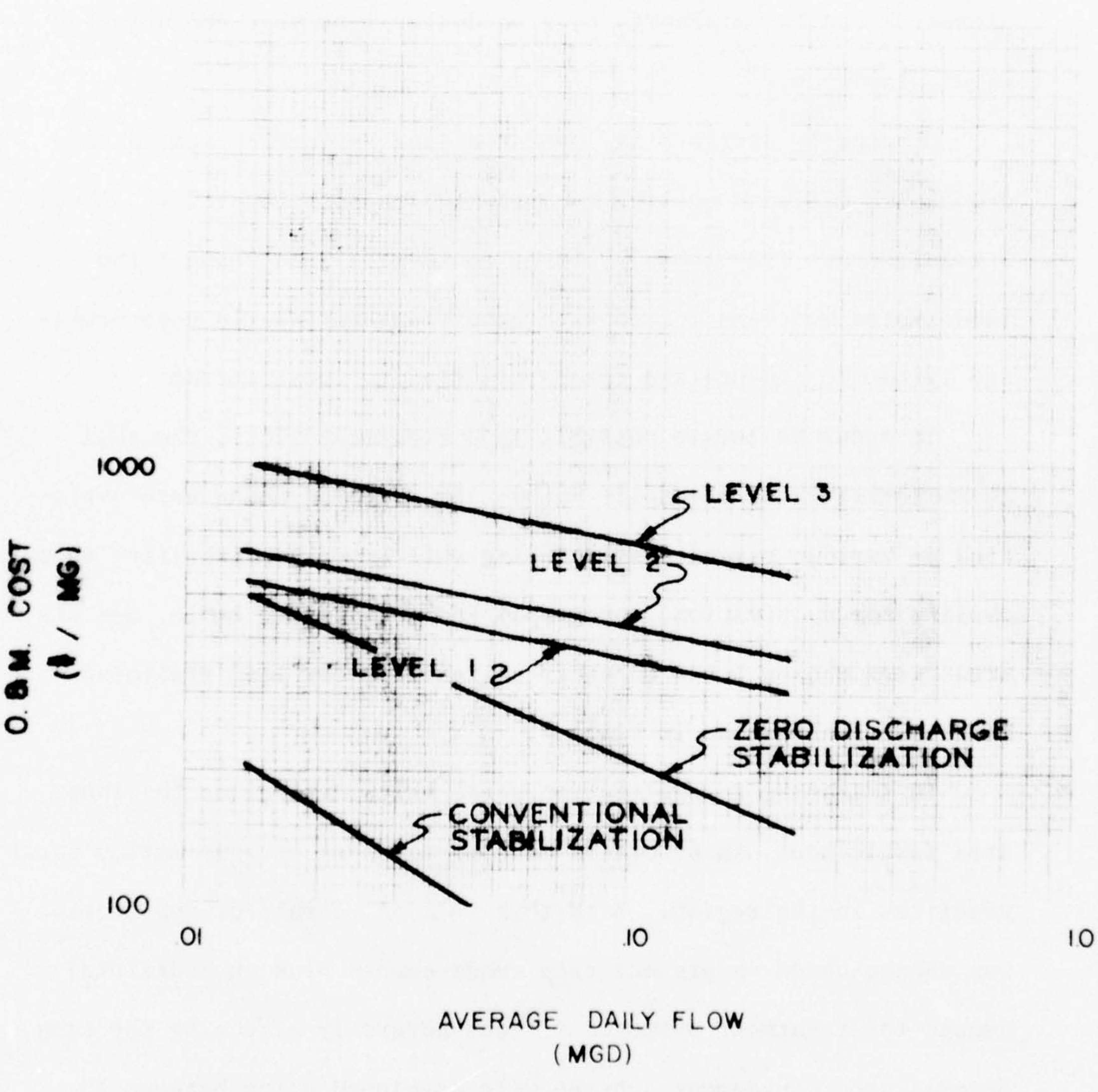
NON-URBAN PLANT

CAPITAL COST

FIGURE 1

HAVENS AND EMERSON, LTD.

OMAHA DISTRICT
CORPS OF ENGINEERS



NON-URBAN PLANT
O & M COST

FIGURE 2

HAVENS AND EMERSON, LTD.

OMAHA DISTRICT
CORPS OF ENGINEERS

percolate to the groundwater. Recent guidelines require that underdrainage discharged to surface streams must meet water quality standards and the discharge to groundwater must meet PHS drinking water standards.

A properly designed and operated land system is assumed to produce an effluent quality consistent with both Level 2 and Level 3 requirements and probably closer to Level 3. In Phase I the land system has been costed with provisions for a grid underdrainage system to capture and return all flow to local streams.

In order to locate possible land treatment sites, the soil characteristics of the soils within 100 miles of Omaha were evaluated on various parameters including soil type, permeability, suitability for cultivation, topography and groundwater table, and six areas were chosen based on their suitability for land treatment. These sites are shown in Plate 4.

In selecting an application rate, which determines the land area requirement, an effort is made to maintain present agricultural practices in the region. With this in mind, a rate of application was chosen based on present crop requirements plus an additional amount for treatment purposes without adversely affecting the crop. Several crop management schemes were developed using between 29 and 37 inches of water per year. Based on these data, a 33 inch/year application rate was used which results in a need for about five months of storage capacity through the winter months. The major urban flow is to be transported to western sites shown on

Plate 4. These are generally the Priority 1 sites around Saunders County and Priority 2 sites in York and Butler Counties, both outside the seven county area. The minor urban and non-urban sites are assumed to be available within one mile of the plant. Most of these sites are in Priority 3 and 4. Those sites required in areas where the soils were not in one of the six highest priorities are very small and such sites could probably be found without undue difficulty. Table 11 shows that a significant amount of irrigation is practiced currently in the seven county area.

TABLE 11

1973 STUDY AREA CROP IRRIGATION

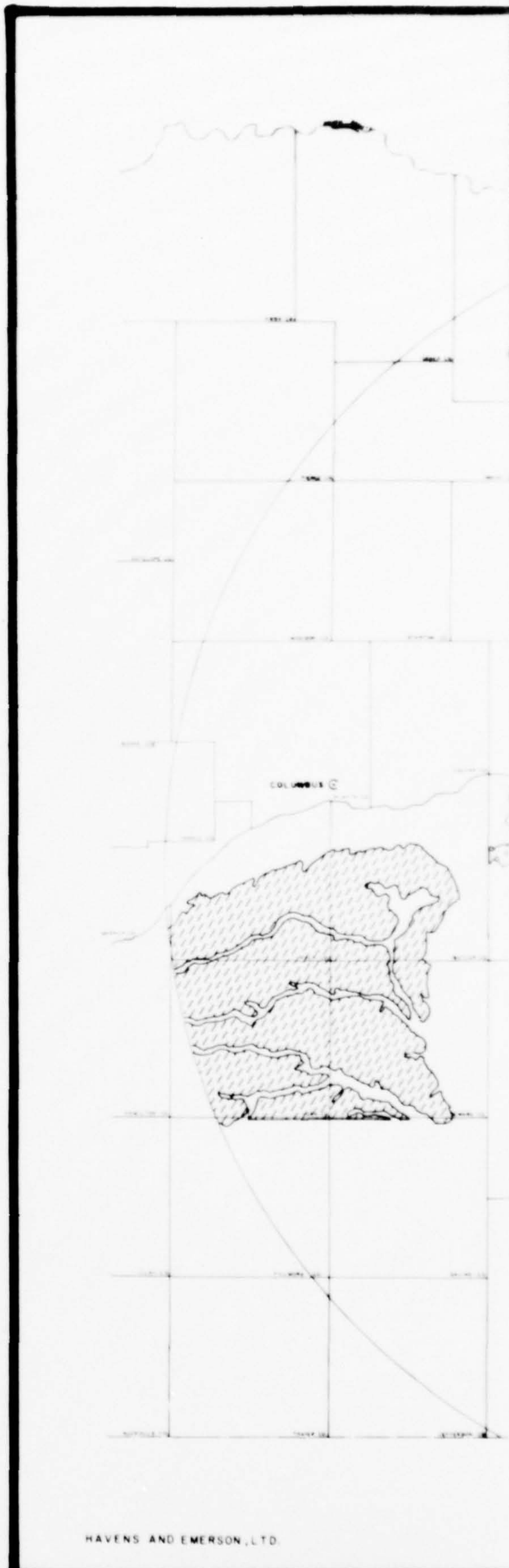
Source	Irrigated Acres	Average Usage Acres-Ft./Yr.	In./Yr.
Iowa Counties			
Ground Water	19,900	20,800	12.6
Surface Water	2,300	2,500	13.0
Total Water	22,200	23,300	13.2
Nebraska Counties			
Ground Water	20,200	20,200	12
Surface Water	3,600	3,600	12
Total Water	23,800	23,800	12
Total Study Area	46,000	47,100	12.4

Source: Interim Report - Regional Water Supply, Henningson, Durham and Richardson, October 1974.

LEGEND

LAND TREATMENT PRIORITY OF SITES

- №1 23 AND 22 - Nebraska
- №2 29 AND 30 - Nebraska
- №3 21, 22 AND 26 - Nebraska
- №4 26 AND 29 - Iowa
- №5 6 AND 14 - Iowa
- №6 12, 18, 33 AND 34 - Iowa



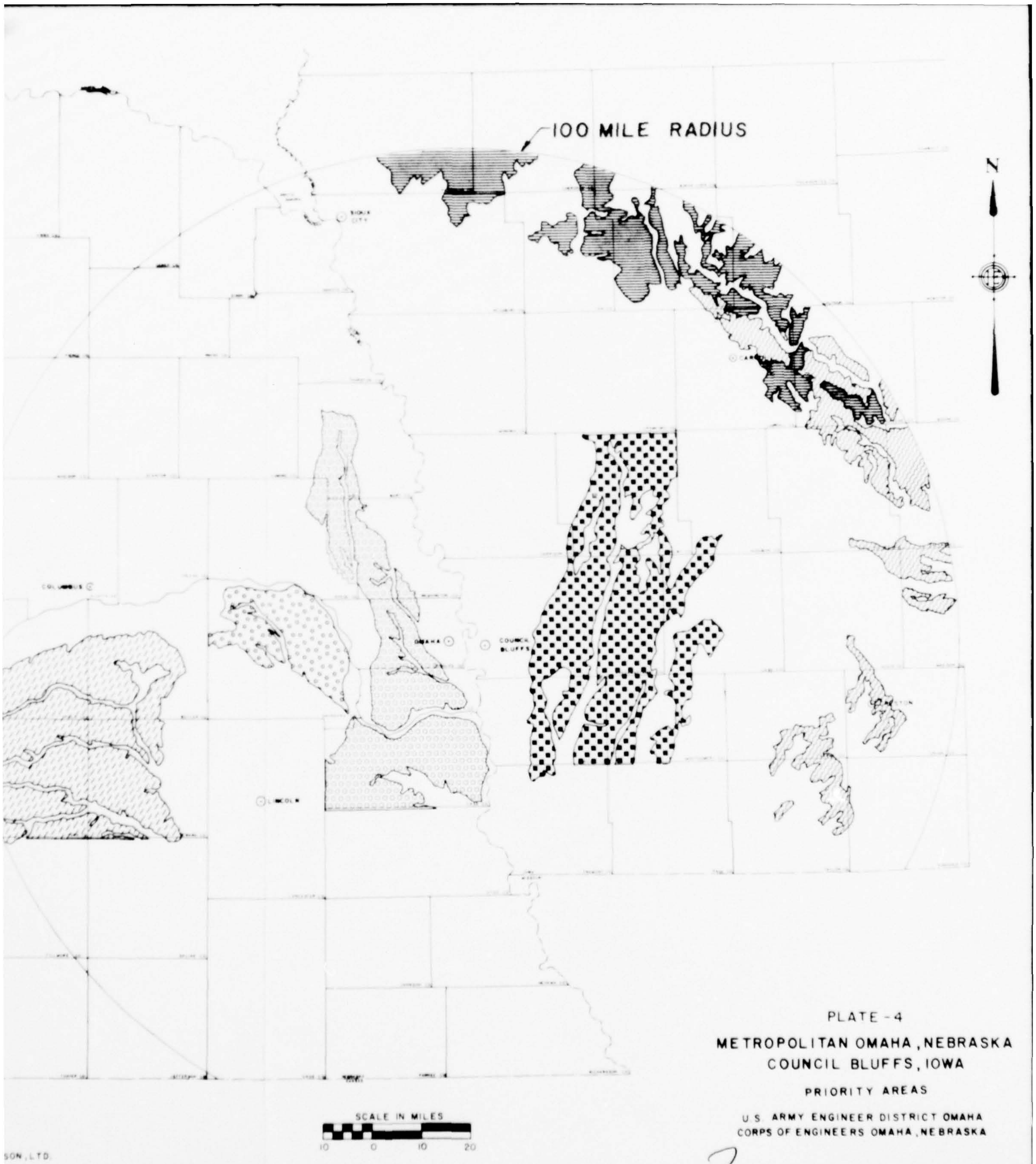


PLATE - 4

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

PRIORITY AREAS

U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

Stormwater Treatment

Design Storm - The 1, 5, and 10 year recurrence interval storms with a 6 hour duration are considered in Phase I. The associated intensities and rainfall depths are shown in Table 12.

TABLE 12

DESIGN STORMS

Recurrence Interval	6 Hr. Intensity	6 Hr. Depth
1 year	0.32 in/hr	1.92 in.
5 year	0.51 in/hr	3.07 in.
10 year	0.59 in/hr	3.55 in.

Runoff Characteristics - The runoff from an area is determined from the rainfall depths in conjunction with the physical characteristics of the area. The annual runoff volumes were developed for various types of land use and are shown in Table 13.

The study area was divided into about 60 drainage subdistricts. Using the design storm and land use patterns, volumes and peak discharges were developed for each of the drainage areas. The Phase I report contains all the detailed information.

Runoff Quality - The concentrations of pollutants carried from the land by storm runoff also varies with land use. The average concentrations used in the study are shown in Table 14.

TABLE 13

MEAN ANNUAL RUNOFF BY LAND USAGE

TYPE OF LAND USE	ANNUAL VOLUME (ft^3/acre)
Residential (2-5 people/acre)	17,500
Residential (5-8 people/acre)	21,000
Residential (8-12 people/acre)	24,500
Residential (12-15 people/acre)	28,000
Residential (15-18 people/acre)	31,500
Residential (18-20 people/acre)	35,000
Industrial and Commercial	52,500
Feedlots	33,500
Rural (Iowa)	15,000
Rural (Eastern Nebraska)	10,000
Rural (East-Central Nebraska)	4,000

TABLE 14

AVERAGE ANNUAL STORMWATER RUNOFF CONCENTRATIONS OF POLLUTANTS

Land Use	Suspended Solids (mg/l)	BOD_5 (mg/l)	COD (mg/l)	Phosphorus as P (mg/l)	Nitrogen as N (mg/l)
Residential (2-5 ppa)(1)	300	20	150	0.70	3.1
Residential (5-8 ppa)	340	22	160	0.66	2.9
Residential (8-12 ppa)	380	24	170	0.62	2.7
Residential (12-15 ppa)	420	26	180	0.58	2.5
Residential (15-18 ppa)	460	28	190	0.54	2.3
Residential (18-20 ppa)	500	30	200	0.50	2.2
Residential Combined Sewer Overflows	250	100	400	4.00	10.0
Commercial and Industrial	500	30	200	0.50	2.2
Feedlots(2)	7,000	5,000	20,000	30.00	300.00
Iowa Agricultural	3,000/	20	30	.20	5.0
Iowa Agricultural	40,000	25.0	350	2.80	65.0
Iowa Rural	500/	0.3	5	.002	1.0
Iowa Rural	5,000	3.5	50	.04	8.0
Nebraska Agricultural	4,000/	3.0	40	.30	7.0
Nebraska Agricultural	40,000	25.0	350	2.60	65.0
Nebraska Rural	700/	0.6	8	.001	1.0
Nebraska Rural	4,000	2.5	20	.020	5.0
Open/Public	200	3.0	50	.20	2.0

1. ppa = people/acre
2. Concentrations for runoff directly off feedlots.
3. A/B; A indicates value when no attempt is made to reduce load.
   B indicates value when best agricultural controls are used.

Treatment Processes - The treatment of urban stormwater runoff presents peculiar design considerations created by the high variability experienced in both influent volumes and pollutant concentrations. Process considerations, therefore, include hydraulic surge control and storage to reduce the instantaneous maximum hydraulic rates and normalize the pollutant concentrations.

Basically, two treatment techniques are developed, each capable of satisfying the stormwater treatment goals. The first technique, Upsystem Storage and Treatment, employs independent stormwater treatment facilities for a particular drainage area with effluent discharged directly to a receiving stream. The second technique, Treatment at the Municipal Plant, includes upstream collection and storage of urban stormwater runoff with regulated discharge to an existing or proposed interceptor for treatment of the combined flow at the municipal wastewater plant. Effluent discharge occurs only at the municipal wastewater treatment plant. Following is a discussion of each of these stormwater treatment techniques.

Upsystem Storage and Treatment - Level 1 includes screening, sedimentation with a two-hour minimum detention, and disinfection. This system will generally achieve a 70% reduction of suspended solids and 40% reduction in biochemical oxygen demand. Level 2 provides additional treatment with the inclusion of microstraining. This system will generally achieve 90 to 67 percent

reduction in suspended solids and BOD, respectively. A schematic of these two systems are illustrated by Figure D-19 in Phase I.

Both earth and concrete storage basins are used in the study. Although earth storage is much less expensive than concrete storage, concrete basins are used in presently urbanized areas due to land costs and the desirability of covered storage for aesthetics and odor control. Earth basins are used in the developing suburban areas where land is more available for storage and adequate buffer zones. When earth basins are employed, concrete chlorine contact tanks designed for a minimum 15 minute detention are used to assure adequate baffling and complete mixing for positive disinfection.

The sludge handling techniques employed are a function of the type of basin (earth or concrete). In the concrete basin, continuous sludge withdrawal is included. This sludge is pumped to an on-site sludge holding basin from which the sludge is periodically drained and hauled by trunk to the municipal wastewater plant for further processing. A separate sludge handling capability is included at the municipal plant for stormwater sludges generated from the concrete basins. In the earth basins, multiple cells are included to allow for periodic dredging (1 to 2 times a year) of the various cells without fully incapacitating the facility. Dredged material would be hauled to a landfill area.

Treatment at the Municipal Plant - The treatment of urban

stormwater runoff at the municipal plant was developed with the intent of providing the flexibility of a high level of stormwater treatment. It was also anticipated that this technique would have considerable merit if high levels of treatment would be required to satisfy water quality standards on receiving streams. Levels 1 and 2 both provide for upsystem storage and regulated pumping into an existing or proposed interceptors which carry the combined flow to the municipal plant. The combined flows received at the plant which are in excess of the treatment plant design flows are diverted to separate stormwater treatment facilities. The schematic of this facility is similar to that used in the upsystem treatment concept, and is illustrated in Phase I on Figure D-20.

The effluent discharged from these Level 1 and Level 2 facilities are equivalent to the Upsystem Storage and Treatment Level 1 and Level 2 quality on particulate materials. The sludge handling at the earth and concrete upsystem storage basins has been developed the same as the Upsystem Storage and Treatment technique.

Facility Sizing - For each of the stormwater treatment techniques, careful consideration was given to the relative component (storage and treatment) cost of each facility to arrive at a reasonable optimization of facility sizing. In general, this optimization depended upon the type of basin employed (i.e., earth or concrete), the level of treatment

desired, and the shape of the storm hydrograph.

Upsystem Storage and Treatment - A cost analysis was made for varying process/peak flow percentages; corresponding storage volumes and treatment rates were calculated and costs were assigned to both constituents. Curves were developed for a range of hydrograph shapes, which showed the minimum cost for the various earth basins at a process flow equal to approximately 10% of peak flow. The corresponding storage volume requirement was 80% of the design storm volume for these earth basins. Unlike the earth basins, the optimum design for the concrete basins varied with hydrograph shape. Therefore, each basin was optimized independently.

The incremental cost of the microstrainer for the Level 2 concrete basin facility has a minor effect on the optimization, requiring a slight increase in storage requirements coupled with a slight decrease in the optimum process or treatment rate.

Treatment at the Municipal Plant - In this case, an optimization of storage volumes, interceptor supplements and wastewater treatment plant additions were made to determine relative sizes of each element.

For the Papillion Creek interceptor system (featuring a combination of earth and concrete upstream storage basins) costs were minimized at a 12 day detention period for all storage basins. In areas outside of the Papillion drainage areas where only earth basins exist, a 30 day detention period

showed a cost minimum. This was due to the much lower cost of earth basins with respect to concrete basins. A 30 day detention period was used as the maximum length of time for which stormwater would be held.

When these longer detention periods are considered it is possible that substantial rainfall will occur before the basin empties the design storm volume. Consequently, the treatment system was designed to store, release and treat the design storm of six-hour duration, in addition to rainfall occurring during the required storage detention period.

The stormwater basins were located for planning purposes by the use of aerial photographs. The range of storage volumes for upsystem storage and treatment varies from 4 acre-feet to 996 acre-feet for a 1-year storm and varied from 9 acre-feet to 2623 acre-feet for a 10-year storm. When storage is required for gradual release to the wastewater treatment plant interceptors storage volumes range from 10 to 1698 acre-feet for a 1-year storm to 17 to 2875 acre-feet for a 10-year storm. Treatment rates varied from 1 cfs to 2052 cfs for the 1-year storm and from 2 cfs to 4983 cfs for the 10-year storm. Pump rates varied from 0.2cfs to 67 cfs for the 1-year storm and from 0.4cfs to 149 cfs for the 10-year storm.

Omaha Combined Sewers - Conveyance of the combined sewer overflows to the Missouri River from Omaha was not part of the Wastewater Management Study. However, alternatives for this

area were developed for the Corps of Engineers by Harza Engineering Company of Chicago, and were used in the *Plans*. Table 15 shows the resulting five alternatives as presented in October 1974 report entitled "*Alternative Plans for Abatement of Pollution from Combined Sewer Overflows*". Brief descriptions of these alternatives follow.

Diked Storage Along Levee (Alt. 2). Combined sewer overflows would be stored in open reservoirs constructed by diking off elongated areas on the riverside of the existing Missouri River levee. Overflows would be mechanically aerated while in storage to prevent odors. The stored waters would be released gradually to the existing interceptor for treatment at the Omaha-Missouri River plant.

Deep Tunnel to Ground Level Storage (Alt. 4A). The elevation of the combined sewers would provide enough energy for conveyance of combined sewage through a tunnel to a diked reservoir across the Missouri River north of Council Bluffs. Stored overflows would be aerated and gradually pumped back to the interceptor for treatment at the Missouri River plant.

Excavated Storage Deep Tunnel to Ground Level Storage (Alt. 4B). This alternative is a modification of alternative 4A in which the northern and southern zones of the combined sewer area would be dealt with individually. Low cost, shallow excavated reservoirs in the Carter Lake area would be used for storage of overflows from the northern zone. A tunnel to

TABLE 15

COST FOR OMAHA COMBINED SEWER OVERFLOWS*
($ million)

	Alternative	Capital	O&M	Present Worth
2	Diked Storage along levee	42.6	2.6	83.2
4A	Deep Tunnel to ground level storage	91.5	2.7	134.0
4B	Excavated storage north, Deep tunnel south	72.1	2.7	117.8
5A	Deep tunnel with mined storage	121.6	3.5	173.9
B	Deep tunnel to Papillion Creek	126.0	3.7	196.6

*Based on 1 year recurrence interval without treatment costs.

ground level storage located across the river, south of Council Bluffs, would serve the southern zone.

Deep Tunnel to Mined Storage (Alt. 5A). This alternative would use a smaller diameter tunnel than the ones considered in alternatives 4A and 4B and would carry flows from North to South, discharging by gravity to a mined storage reservoir located 500 to 600 feet below ground. Diversion structures and drop shafts at the outfalls would allow diversion of the overflows to the tunnel and the storage chambers.

Deep Tunnel to Papillion Creek (Alt. B). This alternative entails a deep tunnel conveyance to a mined storage facility near the Papillion Creek Plant. The objective would be to convey the overflows to a central location for potential disposal at the Papillion Creek Plant. This plan could also eliminate the proposed secondary expansion of the Missouri River treatment plant by conveying the primary effluent thru the deep tunnel to the Papillion Creek area.

COST METHODOLOGY

Present Worth

A major part of any comparative analysis of alternatives is based on cost. The methodology used in this study to compare costs of the various alternatives is based on the concept of present worth. The present worth technique has the advantage of being simple, direct, and provides a valid number for comparison of alternatives; the lowest present worth value represents the most economical alternative. A disadvantage of the method is that the present worth is not useful for estimating annual capital expenditures, and is not directly applicable to rate determinations. In order to perform the present worth analysis, each facility, treatment plant, sewer, etc. is designed and costed to obtain the capital expenditures needed for construction. The components are then phased in accordance with the plan and a yearly cost of operation and maintenance developed. Present worth values are then determined for each phased facility for both capital and operation and maintenance expenditures. The alternatives can then be compared on an equal basis involving the present worth value.

Base Costs

Capital costs and operation and maintenance costs are based on July, 1974 dollars. EPA Sewerage Construction Cost indexes of 209 and 228 were used for treatment plants and sewer lines, respectively. The capital costs presented in the report

are actual construction cost estimates but a contingency factor is incorporated into the present worth value. For capital expenses an overall contingency factor of 25% is added to account for legal, administrative and engineering expenses and for unforeseen elements. A 15% factor is added to operation and maintenance estimates to provide for unforeseen elements in the costing procedure.

Present Worth Factors

The EPA guidelines are followed in the present worth procedure. A discount rate of 6-7/8% is used as specified by the Water Resources Council for FY 1974. The salvage value is determined by straight line depreciation. The lives assumed for each facility varies as follows:

Treatment Plants	- 30 years
Sewers	- 75 years
Storage Basins	- 50 years
Pumping Station	- 20 years
Irrigation Facilities	- 30 years

The economic analysis period is from 1975-2020.

PRESENTATION OF PLANS

Description

After careful review of the goals and objectives of the Wastewater Management Study and the specific plan development variables, eight conceptual alternative plans were formulated in Phase I for preliminary design and costing. A general description of these plans is shown in Table 16, as related to the plan development variables. The treatment technology employed at the major, minor, and non-urban plants is designated "Treatment & Discharge" for the conventional treatment plants with direct discharge to the receiving stream or "Land Treatment System" for secondary effluent application on land systems. The treatment concept employed for the urban stormwater runoff is also indicated as "Upsystem Treatment and Discharge" or "Conveyance". The degree of regionalization is indicated by the number of plants within each of the categories. Plates C-1 through C-11, reproduced from Phase I, and exhibited in Appendix D, illustrate the physical layout of each Regional Wastewater Management Plan.

The following provides a discussion of each plan and its formulation strategy.

Plan I (Plate C-1)

Plan I is the base plan for the study and is therefore used as the basis of comparison for several of the other plans. This plan is compatible with MAPA's Plan C with the

TABLE 16

GENERAL DESCRIPTION

REGIONAL WASTEWATER MANAGEMENT PLANS

PLAN	BRIEF DESCRIPTION	MUNICIPAL WASTEWATER SYSTEMS: MAJOR URBAN	MUNICIPAL WASTEWATER SYSTEMS: MINOR URBAN	MUNICIPAL WASTEWATER SYSTEMS: NON-URBAN	COMBINED SEWER OVERFLOW & URBAN STORMWATER RUNOFF SYSTEMS: OMAHA-MO. RIVER	COMBINED SEWER OVERFLOW & URBAN STORMWATER RUNOFF SYSTEMS: PAPILLION BASIN	COMBINED SEWER OVERFLOW & URBAN STORMWATER RUNOFF SYSTEMS: COUNCIL BLUFFS
I	Basic Plan	3 Plants Treatment & Discharge	7 Plants Treatment & Discharge	34 Plants Treatment & Discharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge
II	Basic Plan with limited extension of Papillion Creek Interceptor System	3 Plants Treatment & Discharge	11 Plants Treatment & Discharge	34 Plants Treatment & Dicharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge
III	Basic Plan with stormwater treatment variation	3 Plants Treatment & Discharge	7 Plants Treatment & Discharge	34 Plants Treatment & Discharge	Conveyance to Missouri River Plant for treatment	Conveyance to Papillion Creek Plant for treatment	Conveyance to Mosquito Creek Plant for treatment
IV	Regionalization at Papillion Plant	2 Plants Treatment & Discharge	7 Plants Treatment & Discharge	34 Plants Treatment & Discharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge
V	Regionalization with stormwater treatment variation	2 Plants Treatment & Discharge	7 Plants Treatment & Discharge	34 Plants Treatment & Discharge	Conveyance to Papillion Creek Plant for treatment	Conveyance to Papillion Creek Plant for treatment	Conveyance to Mosquito Creek Plant for treatment
VI	Land treatment systems for all wastewater	3 Secondary Plants Transmission to Remote Land Treatment System	7 Secondary Plants Transmission to Local Land Treatment System	34 Secondary Plants Transmission to Local Land Treatment System	Conveyance to Missouri River Plant for treatment and Transmission to Remote Land Treatment System	Conveyance to Papillion Creek Plant for treatment and Transmission to Remote Land Treatment System	Conveyance to Mosquito Creek Plant for treatment and Transmission to Remote Land Treatment System
VII	Combination of land treatment system and treatment and discharge	3 Plants Treatment & Discharge	11 Secondary Plants Transmission to Local Land Treatment System	34 Secondary Plants Transmission to Local Land Treatment System	Conveyance to Missouri River Plant for treatment	Upsystem Treatment and Discharge	Upsystem Treatment and Discharge
VIII	Combination of land treatment system and treatment and discharge	3 Secondary Plants Transmission to Remote Land Treatment System	7 Plants Treatment & Discharge	34 Plants Treatment & Discharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge	Upsystem Treatment & Discharge

inclusion of individual upsystem treatment plants for urban stormwater runoff. The Papillion sewer system is extended in this plan to Bellevue, Bennington, Elkhorn, and Gretna.

Plan II (Plate C-2)

Plan II provides lesser extension of the Papillion sewer system (reduced regionalization) as compared to Plan I. This results in four additional permanent minor urban plants at Bellevue, Bennington, Elkhorn, and Gretna. The other major, minor, and non-urban plants are the same as Plan I. Individual upsystem treatment plants are provided for the urban stormwater runoff.

Plan III (Plate C-3)

Plan III provides a wastewater treatment facilities layout identical to Plan I. However, in this plan there is upsystem storage of the urban stormwater runoff with regulated discharge to the major sanitary interceptors for treatment at the municipal plant sites. Alternative 5A from Harza Engineering report, June, 1974, was incorporated into this plan for the Omaha-Missouri River combined sewer area. Alternative 5A consists of conveyance of combined sewer overflow by deep tunnel to mined storage below the Missouri River treatment plant. This plan provides a comparison of stormwater treatment techniques.

Plan IV (Plate C-4)

Plan IV provides greater regionalization than Plan I

by phasing out the Omaha-Missouri River plant and conveying this wastewater to the Papillion Creek plant. The Papillion Creek sewer system is identical to Plan I, as is the handling for urban stormwater runoff with individual upsystem treatment plants. This plan, therefore, provides a comparison of more extensive regionalization of treatment facilities.

Plan V (Plate C-5)

Plan V provides a wastewater treatment facilities layout identical to Plan IV. However, in this plan there is upsystem storage of the urban stormwater runoff with regulated discharge to the major sanitary interceptors for treatment at the municipal plant sites. Alternative B, *Harza Engineering Report*, June, 1974, was incorporated into this plan for the Omaha-Missouri River combined sewer area. Alternative B consists of conveyance of combined sewer overflow by deep tunnel to mined storage near the Papillion Creek plant. This plan provides a comparison of stormwater treatment techniques.

Plan VI (Plates C-6 and C-7)

Plan VI provides a wastewater treatment and stormwater treatment facilities layout identical to Plan III. However, in this plan, only Level 1 or secondary treatment is achieved at these facilities, with this effluent transported to land treatment systems.

In the Minor and Non-Urban facilities, the effluent is stored and used for irrigation at local sites. The Major

Urban secondary effluents are combined near the Papillion Creek plant and transported to irrigation sites west of the urban area. The sites required by 1995 are in the Saunders County area. 2020 flows will require additional sites in the Butler and Seward County areas.

The plan provides for the maximum development of land treatment and irrigation water for a comparison of land treatment systems with upgraded conventional treatment plants. It should be noted that the stormwater applied to the land treatment systems receives a higher degree of treatment than the stormwater does in Plans I through V.

Plan VII (Plates C-8 and C-9)

Plan VII provides a wastewater treatment and stormwater facilities layout very similar to Plan II. The only exceptions are that the Bellevue flow is transported to the Papillion Creek plant and that Boys Town becomes a permanent minor urban plant. In this plan, however, all minor urban and non-urban plants employ local land treatment systems and the major urban plants employ upgraded conventional treatment with discharge to the Missouri River. Stormwater is handled by individual upsystem treatment plants with the exception of the Omaha-Missouri River combined sewer area for which Alternative 5A from Harza Engineering report, June, 1974, was used.

This plan provides the maximum amount of in-basin land treatment systems.

Plan VIII (Plates C-10 and C-11)

This plan provides a wastewater treatment and stormwater treatment facilities layout identical to Plan I. The Minor and Non-Urban facilities are designed as upgraded conventional treatment plants with direct discharge to the receiving streams. The Major Urban facilities provide secondary treatment with their effluent transported to the western land sites. All stormwater is handled by individual upsystem treatment plants.

This plan provides further insight into land treatment systems and provides the maximum nutrient value for amount of water transported to large distant sites.

Costs

Table 17 shows the total present worth summaries for Plans I through VIII, with the variations due to the alternative futures (Concepts A, B, C, and D), level of treatment (1, 2, and 3), and design storms (1, 5, and 10 year).

A comparison of the variations with levels shows the general trend of increasing cost with the Levels. The increase between Level 1 and Level 2 is caused primarily by the wastewater facilities. The stormwater and wastewater facilities cause the major increase from levels 2 to 3. Plans III, V and VI exhibit less increase between levels 2 and 3 indicating that storage and conveyance of stormwater becomes more cost-effective at higher levels. The variations with alternative futures are slight with Concept C generally being the lowest in cost.

TABLE 17

TOTAL PRESENT WORTH SUMMARY
($ Million)

Component	Design Storm	Concept A Level 1	Concept A Level 2	Concept A Level 3	Concept B Level 1	Concept B Level 2	Concept B Level 3	Concept C Level 1	Concept C Level 2	Concept C Level 3	Concept D Level 1	Concept D Level 2	Concept D Level 3
(PLAN I)													
	Total 1 Year	584	661	781	600	684	803	563	640	758	580	656	785
	Total 5 Year	829	906	1,109	846	930	1,123	804	881	1,064	827	903	1,103
	Total 10 Year	971	1,048	1,305	973	1,057	1,268	936	1,013	1,215	963	1,039	1,297
(PLAN II)													
	Total 1 Year	585	664	795	603	694	815	562	642	762	581	660	790
	Total 5 Year	833	912	1,115	852	943	1,138	812	887	1,072	830	909	1,110
	Total 10 Year	975	1,054	1,300	979	1,070	1,283	939	1,019	1,223	966	1,045	1,304
(PLAN III)													
	Total 1 Year	670	747	788	666	750	784	625	702	739	665	741	781
	Total 5 Year	847	909	970	821	905	944	794	871	912	832	908	953
	Total 10 Year	986	1,063	1,113	932	1,016	1,057	930	1,007	1,050	948	1,024	1,073
(PLAN IV)													
	Total 1 Year	641	718	836	647	729	839	620	696	801	640	717	833
	Total 5 Year	897	974	1,164	902	984	1,168	870	946	1,116	896	973	1,160
	Total 10 Year	1,039	1,116	1,349	1,029	1,111	1,313	1,002	1,078	1,267	1,032	1,109	1,354
(PLAN V)													
	Total 1 Year	720	797	824	704	786	812	674	750	776	713	790	882
	Total 5 Year	895	972	1,006	860	942	971	848	924	949	880	957	990
	Total 10 Year	1,035	1,112	1,150	972	1,054	1,085	980	1,056	1,088	998	1,075	1,111
(PLAN VI)													
	Total 1 Year	670	1,065	1,077	666	1,038	1,047	625	995	1,004	665	1,074	1,085
	Total 5 Year	847	1,252	1,269	821	1,203	1,217	794	1,174	1,187	832	1,254	1,270
	Total 10 Year	986	1,404	1,425	932	1,319	1,335	930	1,315	1,330	948	1,377	1,397
(PLAN VII)													
	Total 1 Year	497	583	665	412	614	689	473	559	636	486	572	645
	Total 5 Year	679	765	901	693	795	921	649	735	853	676	762	895
	Total 10 Year	780	866	1,016	779	881	1,013	740	826	952	771	857	1,046
(PLAN VIII)													
	Total 1 Year	584	852	962	600	858	961	771	830	927	580	849	955
	Total 5 Year	840	1,108	1,290	855	1,113	1,290	1,021	1,080	1,242	836	1,105	1,282
	Total 10 Year	982	1,250	1,475	982	1,240	1,435	1,153	1,212	1,393	972	1,241	1,476

The comparisons of Plan cost permit some preliminary judgements. Comparison of Plans I and II indicates that the regionalization of the sewer system is cost effective although the cost difference is slight. Regionalization of treatment facilities by phasing out the Missouri River Plant is indicated to be more expensive by comparing Plans IV and I. Conveyance of stormwater to the municipal plant is shown by comparing Plans I and III and Plans IV and V. Conveyance is generally higher in cost than upsystem treatment in both comparisons although the difference is slight in the higher levels. Level 3 costs in Plan IV and V indicate conveyance is less costly. The Level 1 costs for Plans II and VII indicate that the handling of stormwater by tunnel in the Missouri River district is less costly than the storage and treatment concept used in Plan II. The land treatment Plans VI, VII and VIII indicate that handling stormwater in land systems is more expensive than separate stormwater treatment.

Impacts

In comparing the Regional Wastewater Management Plans, a number of evaluations should be considered in addition to costs. This section presents some of the physical parameters required for proper evaluation of the alternatives.

Annual Pollutant Load Reductions - Table 18 presents a general summary of the influent and effluent pollutant loads of wastewater and stormwater treatment facilities for Concept A

TABLE 18

COMPARISON OF ANNUAL POLLUTANT LOADS - 1995, CONCEPT A

Parameter	Influent**	Level 1 Effluent 1 Yr.*	Level 1 Effluent 5 Yr.*	Level 1 Effluent 10 Yr.*	Level 2 Effluent 1 Yr.*	Level 2 Effluent 5 Yr.*	Level 2 Effluent 10 Yr.*	Level 3 Effluent 1 Yr.*	Level 3 Effluent 5 Yr.*	Level 3 Effluent 10 Yr.*
Suspended Solids										
Wastewater (Tons)	94,706	5,158	5,158	5,158	3,082	3,082	3,082	419	419	419
Stormwater (Tons)	48,626	18,186	15,949	15,463	18,186	15,949	15,463	9,433	6,564	5,932
Total (Tons)	143,332	23,344	21,107	20,621	21,268	19,031	18,545	9,852	6,983	6,351
% Reduction	-	83.7	85.3	85.6	85.2	86.7	87.1	93.1	95.1	95.6
BOD										
Wastewater (Tons)	87,442	4,129	4,129	4,129	2,010	2,010	2,010	1,014	1,014	1,014
Stormwater (Tons)	4,474	2,872	2,756	2,728	2,872	2,756	2,728	1,790	1,597	1,552
Total (Tons)	91,916	7,001	6,885	6,857	4,882	4,766	4,738	2,804	2,611	2,566
% Reduction	-	92.3	92.5	92.5	94.7	94.8	94.8	96.9	97.2	97.2
Phosphorus										
Wastewater (Tons)	1,904	994	994	994	249	249	249	20	20	20
Stormwater (Tons)	134	67	62	60	67	62	60	48	41	40
Total (Tons)	2,038	1,061	1,056	1,054	316	311	309	68	61	60
% Reduction	-	47.9	48.2	48.3	84.5	84.7	89.8	96.7	97.0	97.1
Nitrogen										
Wastewater (Tons)	9,704	4,796	4,796	4,796	4,671	4,671	4,671	1,243	1,243	1,243
Stormwater (Tons)	458	401	396	396	401	396	396	384	378	372
Total (Tons)	10,162	5,197	5,192	5,192	5,072	5,067	5,067	1,627	1,621	1,615
% Reduction	-	48.9	48.9	48.9	50.1	50.1	50.1	84.0	84.0	84.1

* Stormwater Treatment Facilities are designed for storm of given recurrence interval.
** Annual Influent Volumes (MG): Wastewater = 49,348
Stormwater = 30,343
Total = 79,691

in 1995. The loads are presented for the three levels of treatment. Effluent Level 1 involves Level 1 wastewater and Level 1 stormwater treatment levels. Effluent Level 2 consists of Level 2 wastewater and Level 1 stormwater. Effluent Level 3 consists of Level 3 wastewater and Level 2 stormwater. The loads are separated into wastewater and the three stormwater designs; 1, 5, and 10 year.

The percent removals increase as the level of treatment increases but the amount of increase varies with parameter. The BOD removals vary least with suspended solids next and the phosphorus and nitrogen removals vary the most.

Populations Served - The total population served by the plans is about 1,009,000 persons but the location and extent of the service areas do vary with the plans and alternative futures. Table 19 shows the population served by the Major, Minor and Non-Urban plants.

Number of Facilities - The number of wastewater treatment plants is greatly reduced from the present in all plans as illustrated in Table 20. The number of non-urban plants remain constant at 34 in all plans. The variations in the major and minor urban plants are due to regionalization in the sewer system or the major urban layout.

Also shown on this table are the number of stormwater treatment facilities and/or storage facilities required for each of the Regional Wastewater Management Plans.

TABLE 19

POPULATIONS SERVED BY WASTEWATER TREATMENT PLANTS
(1,000)

Plan	Category	Concept A	B	C	D
I, III, IV, V, VI, VIII	Major	942	857	942	942
	Minor	38	123	38	38
	Non-Urban	29	29	29	29
II	Major	909	765	909	910
	Minor	71	215	71	70
	Non-Urban	29	29	29	29
VII	Major	919	775	918	919
	Minor	61	205	62	61
	Non-Urban	29	29	29	29

TABLE 20

NUMBER OF TREATMENT FACILITIES PER PLAN

	Plan	Category	Concept A	Concept B	Concept C	Concept D
Wastewater	I, III, VI, VIII	Major	3	3	3	3
		Minor	7	9	7	7
		Non-Urban	34	34	34	34
	II, VII	Major	3	3	3	3
		Minor	11	13	11	11
		Non-Urban	34	34	34	34
	IV, V	Major	2	2	2	2
		Minor	7	9	7	7
		Non-Urban	34	34	34	34
Stormwater Upsystem Treatment	I, II, IV VIII	Earth	27	24	24	28
		Concrete	23	23	23	23
	VII	Earth	27	24	24	28
		Concrete	9	9	9	9
Storage & Conveyance	III, V VI	Earth	27	24	24	28
		Concrete	14	14	14	14

Sewer Construction - Sewage and stormwater transmission involves a complex grid of piping ranging from house connections laterals and inlet pipes to the major trunk and interceptor lines which carry the flow to the treatment and/or storage sites. The facilities considered in this study are interceptors, force mains, and tunnels. The lengths of these facilities for the various plans are shown in Table 21. The interceptor is generally constructed by cut and backfill methods. The tunnel is constructed in a deep stratum by tunneling techniques which produce minimal surface disruption. The force main is a pressurized pipe conveying water to a higher elevation and generally involves smaller pipe sizes but involves additional energy requirements for pumping.

TABLE 21

SEWER LENGTHS
(1,000 ft.)

Plan	I	II	III	IV	V	VI	VII	VIII
Interceptors	392	330	392	392	392	392	330	392
Tunnels	-	-	52	-	98	52	52	-
Force Mains								
Wastewater	78	57	78	78	78	78	78	78
Effluent to Land								
Major Urban	-	-	-	-	-	331	-	331
Minor Urban*	-	-	-	-	-	37	58	37
Non-Urban	-	-	-	-	-	180	180	-
Total*						548	238	368

*11,000 ft. added in Concept B for "New Towns"

Land Requirements - Additional land is needed to accomplish any of the Plans. This land is required for wastewater plants, stormwater storage and treatment and for land treatment. The small amount of additional land for wastewater treatment plant expansion is not addressed in this study since a detailed analysis of each plant site would be required. The land area requirements for stormwater treatment and land treatment are significant and deserve consideration.

Table 22 shows the land required by the two stormwater treatment techniques; upsystem storage and treatment and treatment at the municipal plant. The table shows the land required for both the concrete and earth basins.

Table 23 shows the land requirements for the land treatment plans. These requirements are divided between irrigation area and reservoir surface area. Plan VI is further divided into the seven county in-basin requirements and the out of basin requirements. Plan VII areas are all in-basin and Plan VIII are out of basin.

Impacts of Papillion Reservoirs - Twenty dams and reservoirs, exhibited in Appendix A, are being built in the Papillion watershed for flood control. A dual benefit is the use of the reservoirs for recreation (no body contact sports) and wildlife areas. The smallest of the earthfilled dams has a watershed area of about two square miles - the largest, about 35 square miles.

TABLE 22

LAND AREA REQUIREMENTS FOR STORMWATER TREATMENT FACILITIES
(acres)

Design Storm	Earth Basins				Concrete Basins			
	A	B	C	D	A	B	C	D
Upsystem Storage and Treatment								
Level 1								
1 Year	668	450	492	658	160	161	113	157
5 Year	1,309	882	964	1,289	285	287	201	280
10 Year	1,920	1,293	1,414	1,891	351	353	248	344
Level 2								
1 Year	661	450	405	658	176	178	173	173
5 Year	1,311	892	803	1,305	313	317	308	308
10 Year	1,920	1,307	1,176	1,911	383	387	376	376
Upsystem Storage with Treatment at Municipal Plant								
1 Year	1,379	1,129	870	1,329	189	197	183	203
5 Year	1,979	1,620	1,248	1,907	264	275	256	284
10 Year	2,415	1,977	1,526	2,327	336	350	325	361

TABLE 23

LAND AREA REQUIREMENTS FOR LAND TREATMENT SYSTEMS
(acres)

Plan	Irrigation				Reservoirs			
	A	B	C	D	A	B	C	D
VI								
In Basin	71,000	18,500	7,300	6,900	390	930	400	390
Out Basin	161,000	142,000	152,000	170,000	7,500	6,600	7,100	7,900
VII	76,000	23,600	7,600	7,600	410	1,160	410	410
VIII	109,000	100,000	109,000	109,000	5,100	4,700	4,700	5,100

To address the impact of the Plans on these reservoirs, four sites are analyzed in the Phase I report. Two of these are summarized in this section; site No. 2 and No. 17. Site No. 2 is primarily agricultural and Site No. 17 is primarily urban. Table 24 shows the annual pollutant loads for BOD, suspended solids, phosphorus and nitrogen in 1995. Land use is also presented in the table divided into croplands, urban land (residential, industrial and commercial) feedlot and other (public and private idle land).

The plans incorporate control techniques to reduce inputs to the streams. The controls applied to cropland involve conservation measures prescribed by good agriculture practices. These practices include such items as slope terracing, contour farming, strip cropping, reduction of barren soil surface area, bank stabilization of streams and impoundment controls. The open uncropped areas are assumed to be uncontrolled except for possible measures such as border grass placed to serve as a type of overland flow treatment method. The controls for the urban stormwater designed into the alternatives assume that the upsystem treatment and discharge facilities are all downstream of the reservoir sites, and as a result urban stormwater will not enter the reservoirs. Therefore, the urban drainage loads are virtually eliminated from the reservoirs by the Plans.

The tables indicate that the "cropland" and "other"

TABLE 24

ANNUAL POLLUTANT LOAD TO PAPILLION RESERVOIRS
(Concept)

	1975	1995 Without Control	1995 With Control	% Reduction
Reservoir #2				
BOD (tons/yr)	41	41	9	78
SS (tons/yr)	61,342	61,342	12,932	79
P (#/yr)	7,419	7,419	1,204	84
N (#/yr)	196,366	196,366	40,094	80
Reservoir #17				
BOD (tons/yr)	5	9	1	89
SS (tons/yr)	5,127	274	53	81
P (#/yr)	713	628	107	83
N (#/yr)	17,073	3,372	1,066	68

LAND USE

	Reservoir #2		Reservoir #17	
	1975	1995	1975	1995
Crop (%)	55	55	34	0
Urban (%)	0	0	1	44
Feedlot (%)	0	0	0	0
Other (%)	45	45	65	56

category potentially generate the most significant inputs to the reservoirs. Even in the urban site No. 17 the values indicate that these areas generate 10% - 30% of the potential input, depending on the parameter. With adequate control methods used in the contributing drainage areas, all sites analyzed indicated that good reductions of the inputs are possible; BOD 78-93%; SS 79-82%; P 80-89%; and N 68-83%. Assuming that concentrations are reduced approximately the same as total loads, the present concentrations in the streams should be reduced by approximately 80%. The present sampling information indicates that the median concentration in the basin waters for phosphorus in the summer ranges from 0.16-1.47 mg/l; an 80% reduction indicates these waters could range from 0.03-0.3 mg/l after control methods are implemented.

C. PHASE II ANALYSIS

The initial phases of the Phase II portion of the Wastewater Management Study involve the further analysis of the Phase I plans. The analysis is divided into three general sections:

Component Comparisons
Stream Modeling for Water Quality
Cost Effectiveness

COMPONENT COMPARISONS

In the Phase I report, costs were presented as total plan costs. This section investigates the costs of certain portions of the plans to better evaluate specific problems. The specific problems investigated are:

Combining the Missouri River Plant with the Papillion Creek Plant

Bellevue regionalization

Upsystem stormwater treatment vs. conveyance of the stormwater to the Municipal Plant for treatment

Landtreatment costing procedure

Combining the Missouri River Plant with the Papillion Creek Plant

As part of the Phase II analysis, detailed mass balances and unit sizings were prepared for the major urban plants. Using this information, the cost estimates for the Papillion Creek Plant and the Missouri River Plant were revised. Table 25, using these revised costs for Level 1, shows a comparison of present worths for separate plants (Missouri River and Papillion Creek) versus combined plants (transporting Missouri River pretreatment effluent to the Papillion Creek Plant). The combined plant cost of Papillion

includes the transmission facilities. This analysis indicates the separate plant scheme to be slightly less expensive than the combined plant scheme. This result was also reached in the MAPA report[4] comparing Plans C and D.

Other considerations in this decision include the reliability of facilities, implementation, land availability, and associated environmental impacts. The Phase I and Phase II work done on Stream Modeling of the Missouri River also indicates that the combined plant discharge effect on the water quality of the Missouri River may be more severe than the two plant discharges.

TABLE 25

TWO PLANTS VS. ONE PLANT
PRESENT WORTH
($ 1000)

Separate Plants	CAP.	O&M
Papillion	$32,947	$30,825
Missouri River	39,317	30,360
TOTAL	$72,464	$61,185
GRAND TOTAL	$133,649	
Combined Plants	**CAP.**	**O&M**
Papillion	$72,675	$55,416
Missouri River (Pretreatment)	0	8,994
TOTAL	$72,675	$64,410
GRAND TOTAL	$137,085	

Bellevue Regionalization

Considerable effort has been put into various studies on determination of the cost-effectiveness of extending the Papillion Creek

sewer system to include the Bellevue No. 1 wastewater treatment plant. Table 26 illustrates the final cost comparisons of these studies. The costs as presented in this table are not directly comparable due to differences in costing techniques and assumptions, however, the relative differences do provide a measure of the cost-effectiveness. The MAPA report[4] and the Phase I report[5] show a slight economic benefit (less than 1%) towards the abandonment of the Bellevue No. 1 plant. The Kirkham-Michael report[6] however, shows a slight economic benefit (less than 0.1%) towards maintaining the Bellevue No. 1 plant. The result of all these studies is that the costs are essentially equivalent on a regional basis and therefore the decision may be based on other considerations.

The reliability of the facilities is one of the more important considerations. In general, it can be assumed that the larger facility would be more reliable than the smaller facility for the following reasons.

1. The effects of a mechanical failure would not be as severe on the larger facility due to the flexibility associated with multiple units.
2. The technical expertise associated with a larger facility would be better especially in areas such as laboratory control.
3. The larger facility, due to the greater quantity of wastewater, would provide greater dilution to an

TABLE 26

BELLEVUE COST COMPARISONS

	(1) Maintain Bellevue	(2) Bellevue to Papillion	Percent Difference $[\frac{(1)-(2)}{(1)}] \times 100$
MAPA* ($1000/Year)	4,656	4,611	0.97
Kirkham-Michael** (Dollars/Year)	10,094,178	10,103,054	-0.09
Phase I*** (Present Worth - $1000)	73,322	72,720	0.82

*MAPA, Wastewater Collection and Treatment, June, 1972.
**Kirkham-Michael, Supplement III, Wastewater Treatment Plant No. 1 for Bellevue, Nebraska, March, 1974.
***Havens and Emerson, Ltd., Phase I, Omaha-Council Bluffs. Wastewater Management Study, October, 1974.

industrial waste spill which may upset the smaller facility.

However, in the case of the Bellevue No. 1 being abandoned and the wastewater being pumped via force main to the Papillion Creek plant another reliability factor must be considered. In the event of a mechanical failure of the pump station or force main, it would be necessary for raw sewage to be discharged to the Missouri River if adequate duplication of facilities were not provided. The environmental effects of this reliability factor are potentially more severe than those previously mentioned which favor the larger facility.

The cost comparisons, illustrated previously, are based on Level 1 or secondary treatment at the wastewater treatment plants. As higher levels of treatment are required, however, regionalization becomes more cost-effective.

Environmental impacts to be considered include land use, (negligible difference), disruption due to force main construction, air pollution problems (2 sites vs. 1 site), and solid waste disposal.

Upsystem Stormwater Treatment vs. Conveyance

Phase I considered two basic stormwater treatment techniques: Upsystem treatment and discharge, and conveyance to the municipal plant. Table 27 shows the present worth values associated with these alternatives, excluding the Omaha combined sewer area. These costs indicate that the economic choice is strongly in favor of upsystem

treatment and discharge. However, as the level of treatment is increased, the conveyance to the municipal plant becomes less unfavorable.

TABLE 27

STORMWATER HANDLING*
PRESENT WORTH
($1,000,000)

Concept	Level 1				Level 2			
	A	B	C	D	A	B	C	D
(1) Upsystem Treatment	178.8	185.4	165.8	173.3	215.8	227.0	195.3	224.9
(2) Conveyance to Municipal Plant	339.7	333.0	307.8	340.7	351.0	342.5	312.6	351.2
Ratio $\frac{(2)}{(1)}$	1.89	1.80	1.86	1.97	1.62	1.50	1.60	1.56

*not including Omaha combined sewer area.

Land Treatment Costing Procedure

The Phase I land treatment costs were phased to provide capital facilities in two years: 1985 and 1995 based upon the design years of 1995 and 2020, respectively. Phasing the required facilities in shorter time frames is more realistic in that it would not require excess equipment capital costs.

Table 28 shows the capital present worth values for the three land based plans based on phasing implementation in five-year increment through 2020. The non-phased values are those presented in Phase I, the phased column shows the present worth associated with

TABLE 28

EFFECT OF PHASING ON LAND TREATMENT COSTS

CAPITAL PRESENT WORTH

($1,000,000)

Concept	A		B		C		D	
	Phase I	5 Yr.	Phase I	5 Yr.	Phase I	5 Yr.	Phase I	5 Yr.
Plan VI (1 Yr. Storm)								
Major Urban	93.0	85.0	83.0	77.0	88.0	74.0	98.0	89.0
Minor Urban	4.0	3.0	12.0	10.0	4.0	3.0	4.0	3.0
Non Urban	2.5	2.0	2.5	2.0	2.5	2.0	2.5	2.0
Land Total	99.5	90.0	97.5	79.0	94.5	79.0	104.5	94.0
Plan Total	1,065	1,055	1,038	979	995	979	1,074	1,063
Plan VII								
Major Urban	-	-	-	-	-	-	-	-
Minor Urban	5.0	4.0	16.0	13.0	5.0	4.0	5.0	4.0
Non Urban	2.5	2.0	2.5	2.0	2.5	2.0	2.5	-
Land Total	7.5	6.0	18.5	15.0	7.5	6.0	7.5	4.0
Plan Total	583	581	614	610	559	557	572	570
Plan VIII								
Major Urban	61.0	54.0	55.0	49.0	61.0	54.0	61.0	54.0
Minor Urban	-	-	-	-	-	-	-	-
Non Urban	-	-	-	-	-	-	-	-
Land Total	61.0	54.0	55.0	49.0	61.0	54.0	61.0	54.0
Plan Total	852	845	858	852	830	823	849	842

the shorter phasing schedule.

The cost reduction due to the shorter phasing schedule is not sufficient to alter the Plan costs ranking, but is a significant value.

STREAM MODELING FOR WATER QUALITY

Model Inputs

To evaluate the effect of discharges into the Papillion Creek and the Missouri River, stream modeling of dissolved oxygen (DO) was performed using computer techniques. The model used is a modified form of the DOSAG program, developed and published by the Texas Water Development Board.[7] The details of the model are discussed in the Phase I report.

The inputs required for the DOSAG program are relatively few and easily derived. The inputs can be classified into three major categories: physical stream characteristics, deoxygenation and reaerations rates and waste discharges. The waste discharges considered were those for wastewater treatment plants, combined sewer overflows and stormwater discharges defined in the study. The other categories were derived from previous work by the Nebraska Natural Resource Commission, USEPA and our judgments based on past experience. The scope of this study does not allow for exhaustive analysis and verification of the base parameters. However, consistency in concept and choice of parameters provides results which can be rationally evaluated and analyzed.

Wastewater analysis is based on an initial low flow, high temperature situation with continuous waste discharges. This provides a picture of late summer conditions. As base flow increases and temperature decreases, the effect of the discharge is less severe.

The low flow conditions in the Missouri River based on

historical records indicate two critical conditions within a typical year. The summer 7 day, 10 year low flow is about 25,600 cfs; the winter 7 day, 10 year low flow is 7,000 cfs. The temperatures associated with these flows approaches 0°C for winter and 30°C in the summer. Present planning of the Missouri River water resources[8] infers increasing upstream diversion which could radically change the flow characteristics by 2020. Future 7 day, 10 year low flows are predicted to be 5,100 cfs in the summer and 4,100 cfs in the winter. In the analysis two flows were used; 6,000 and 25,000 cfs.

Stormwater and combined sewer overflow analysis requires special attention. The variability in flow and quality of these discharges is large and not well defined in the study area, or elsewhere. The DOSAG model is the static type which indicates that it analyzes a slug of water as it passes through the stream. The DO at any particular time is based on a combination of oxygen consuming materials, rate of deoxygenation of these materials and natural reaeration of the stream. Given variable storm discharges, analysis is required to choose the combination of waste inputs that produce the maximum effect on a particular slug of water.

With this variability in mind the stormwater effect is analyzed in two parts, the Missouri River discharges and the Papillion discharges on Papillion Creek which were analyzed in Phase I, Figures D-6 through D-17. The Papillion peak discharges do not overlap the peak discharges to the Missouri River from the combined sewer overflow. The following analysis will therefore generally separate

the two.

The following discussions separate the effect of wastewater discharges and the effect of storm and overflow discharges. This approach shows the major impact situations. Need for more detailed study beyond the scope of this report is apparent.

Figure 3 shows the key waste input points on the Missouri River. The points were not all used in each situation but represent a composite of all situations. Table 29 shows the input parameters used in the computer analysis. The table is divided into base parameters, flow inputs and quality inputs. The physical base parameters were chosen based on prior experience and from the Qual II parameters used by EPA in the Papillion Basin. Multiple numbers under one heading indicated that each was used but not for all cases. The wastewater flow inputs were based on the highest 2020 flows for the various growth concepts. An exception to this was on the Papillion waste inputs, in which both high and low flows were used. In the combined sewer overflows, the choice of inputs was based on hydrologic and treatment rates for the storm. The choices were made to provide the maximum input. Effluent quality for the treatment plants was determined from the designs of each. Because of the variability in the combined overflow quality, a range of influent values was used for BOD_u (Ultimate Biochemical Oxygen Demand), NOD (Nitrogenous Oxygen Demand), and DO (Dissolved Oxygen). The inputs for treated levels are placed to correspond to these influent values.

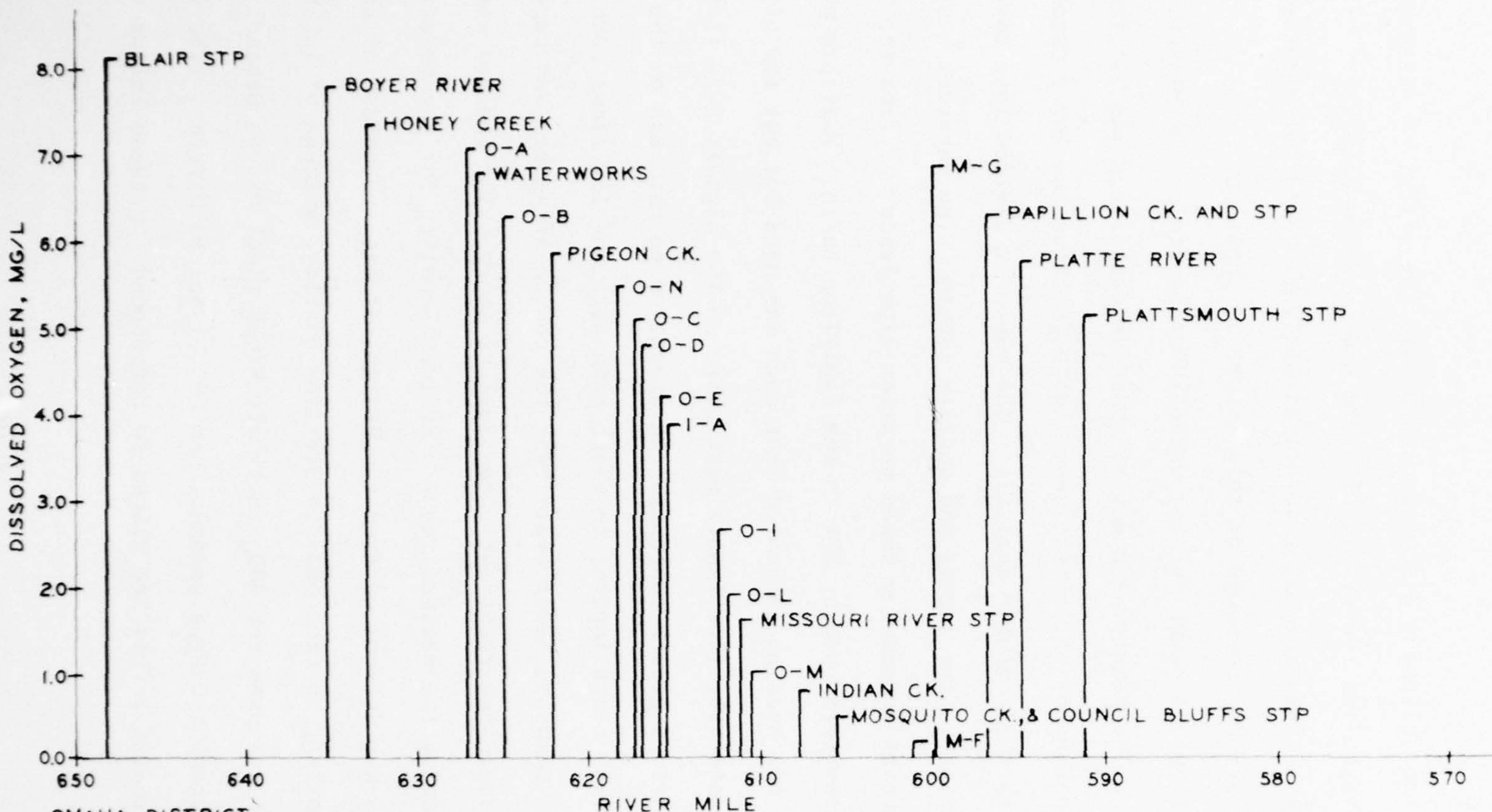


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FIGURE 3
MISSOURI STREAM MODELING

TABLE 29

INPUT PARAMETERS
FOR DOSAG MODEL

	Missouri River	West Papillion	Big Papillion
Base Parameters			
Flow (cfs)	6,000;25,000	0.11	2;15
Temperature (°C)	30;25;20;10	25	25
BOD_5 (mg/l)	3;6	5	5
Carbon K rate	0.2	0.5	0.5
Nitrogen K rate	0.1	0.2	0.2
Reaeration K rate	0.05	0.05	0.05
Q coeff-C	0.324	0.112	0.394
Q exponent-N	0.234	0.401	0.249

Flow Inputs	Flow (cfs)
Treatment Plants	
Blair	8.8
Missouri River	104.2
Council Bluffs	46.1
Papillion	161.5
Plattsmouth	5.9
Bennington	0.73;6.2
Elkhorn	0.96;6.2

	Flow (cfs)		
Combined Overflow	No Treatment	Level 1	Level 2
O-A	900	0	329
O-B	3,400	712	320
O-N	0	564	254
O-C	0	398	117
O-D	0	353	398
O-E	0	0	159
O-I	0	0	64
O-L	0	276	124
O-M	0	261	117
Missouri River	56		
Separate Stormwater			
I-A	0	296	396
M-F	0	28	0
M-G	0	178	178

TABLE 29 - CONTINUED

INPUT PARAMETERS
FOR DOSAG MODEL

Quality Inputs, (mg/l)	Level 1			Level 2		
Treatment Plants	BOD_u	NOD_u	DO	BOD_u	NOD_u	DO
Blair	40	117	2	12	7	2
Missouri River	35	145	2	15	3	2
Council Bluffs	49	150	2	21	5	2
Papillion	47	113	2	11	3	2
Plattsmouth	40	117	2	12	7	2
Bennington	41	126	3	12	5	3
Elkhorn	41	126	3	12	5	3

	BOD_u	NOD_u	DO
Combined Overflows			
No Treatment	150;90	52;37	6;3
Level 1	90;54	33;22	3
Level 2	45;27	17;11	6
Level 3	7.5	2.3	6
Separate Stormwater			
Level 1	30	3	3
Level 2	15	2.5	6

Side Streams				
Papillion Creek	Flow	BOD	NOD	DO
No Treatment	20,000	40	11	6
Level I	7,800	15	5	5
Level 2	7,800	8	4	5
No Storm	15	3	0	90%sat
Platte	619;25,000	3	0	90%sat

Stormwater

Figure 4 shows the effect of the combined sewer overflows on the Missouri River with no treatment. It shows extreme DO depletion for the base condition of 6,000 cfs, 30°C and stormwater quality of 100 mg/l BOD_5. Even the less extreme conditions (lowered temperature and load and increased base flow) show a major negative impact on the River. The initial sag in DO below Blair is caused by the base BOD in the Missouri River. This phenomenon is exhibited in all the figures and is a peculiarity of the modeling technique.

Figure 4 shows the great need for action concerning the combined sewer discharges into the Missouri River.

Figure 5 shows the effect of only the Papillion peak discharges on the Missouri River. No wastewater or stormwater inputs are used above the Papillion input. The effect of the Papillion input is shown for four conditions. The most extreme condition is the existing condition of no treatment of stormwater or combined sewer overflows in the basin. This condition is shown for a base flow of 6,000 and 25,000 cfs in the River. The others show the effect of the peak discharges when Level 1 and Level 2 treatment are employed in the Papillion Basin. These inputs are derived from the Papillion analysis performed in Phase I.

This figure reinforces the preceding figure in showing that stormwater discharges even when treated have a significant effect on the Missouri River.

Figure 6 shows the result of an analysis of the combined

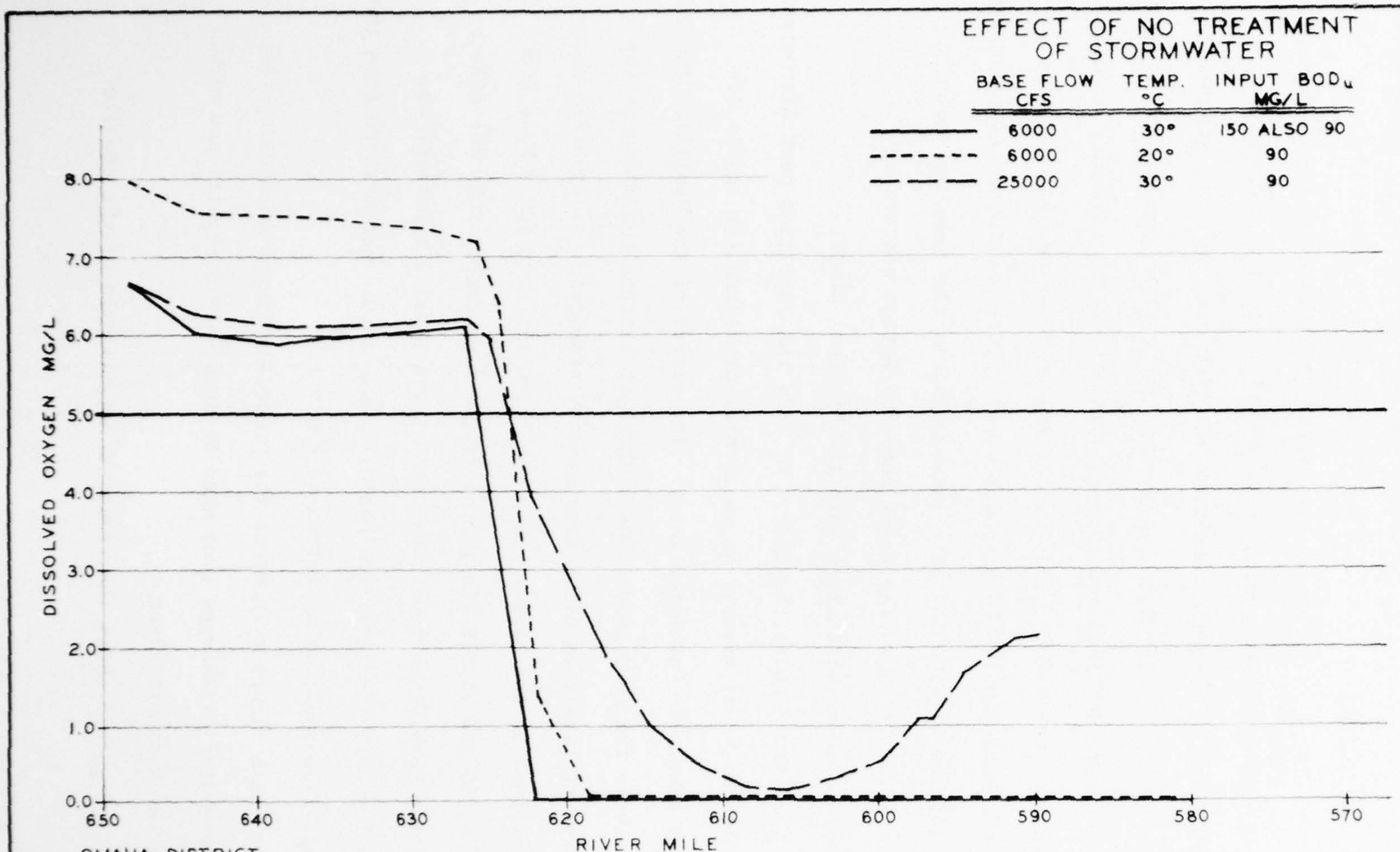

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FIGURE 4
MISSOURI STREAM MODELING

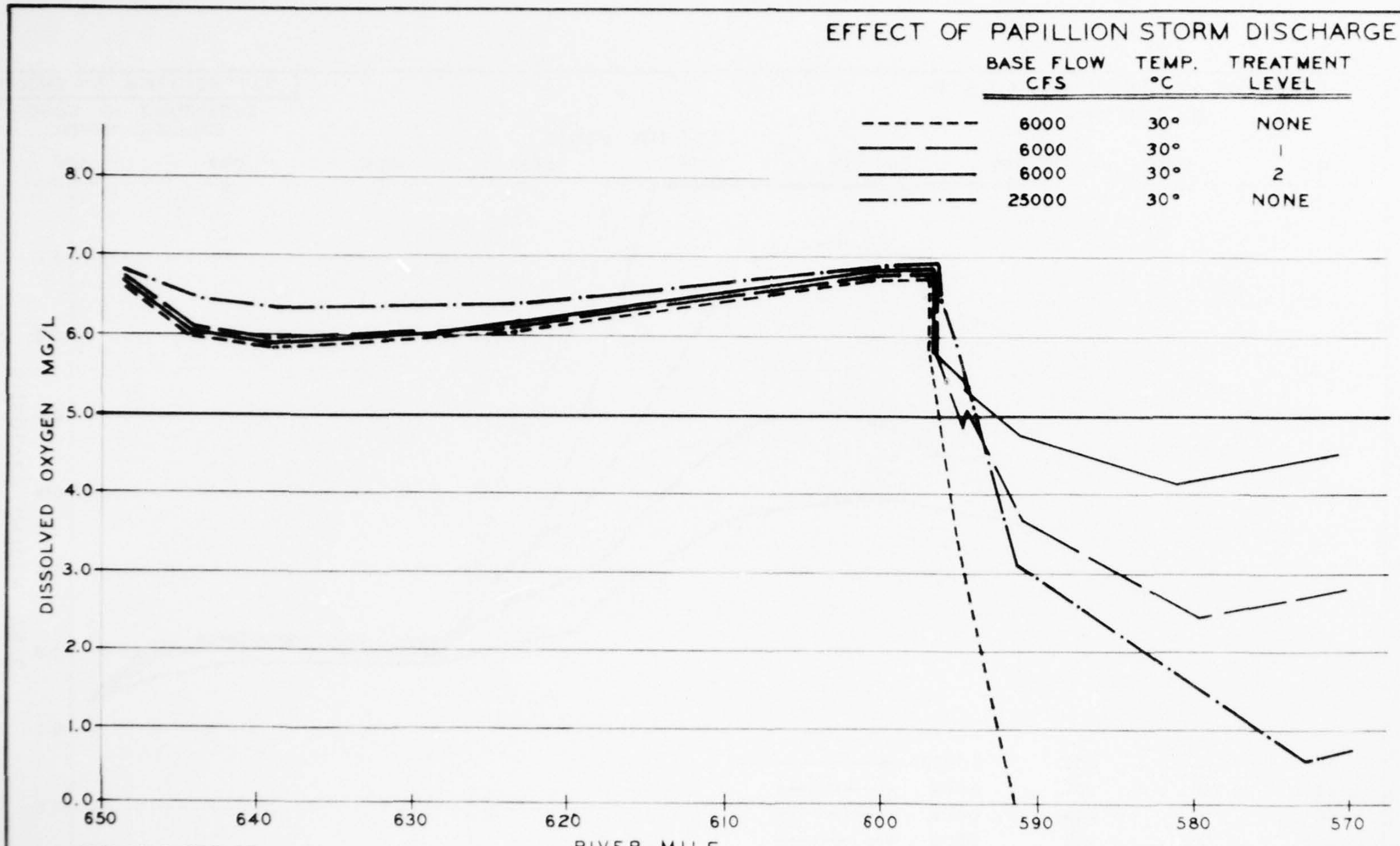

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FIGURE 5
MISSOURI STREAM MODELING

AD-A041 935 ARMY ENGINEER DISTRICT OMAHA NEBR F/G 8/6
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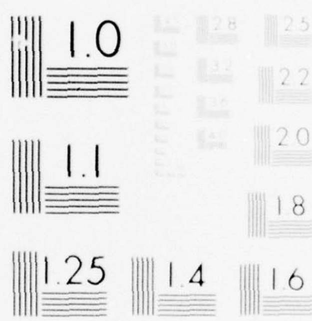
1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

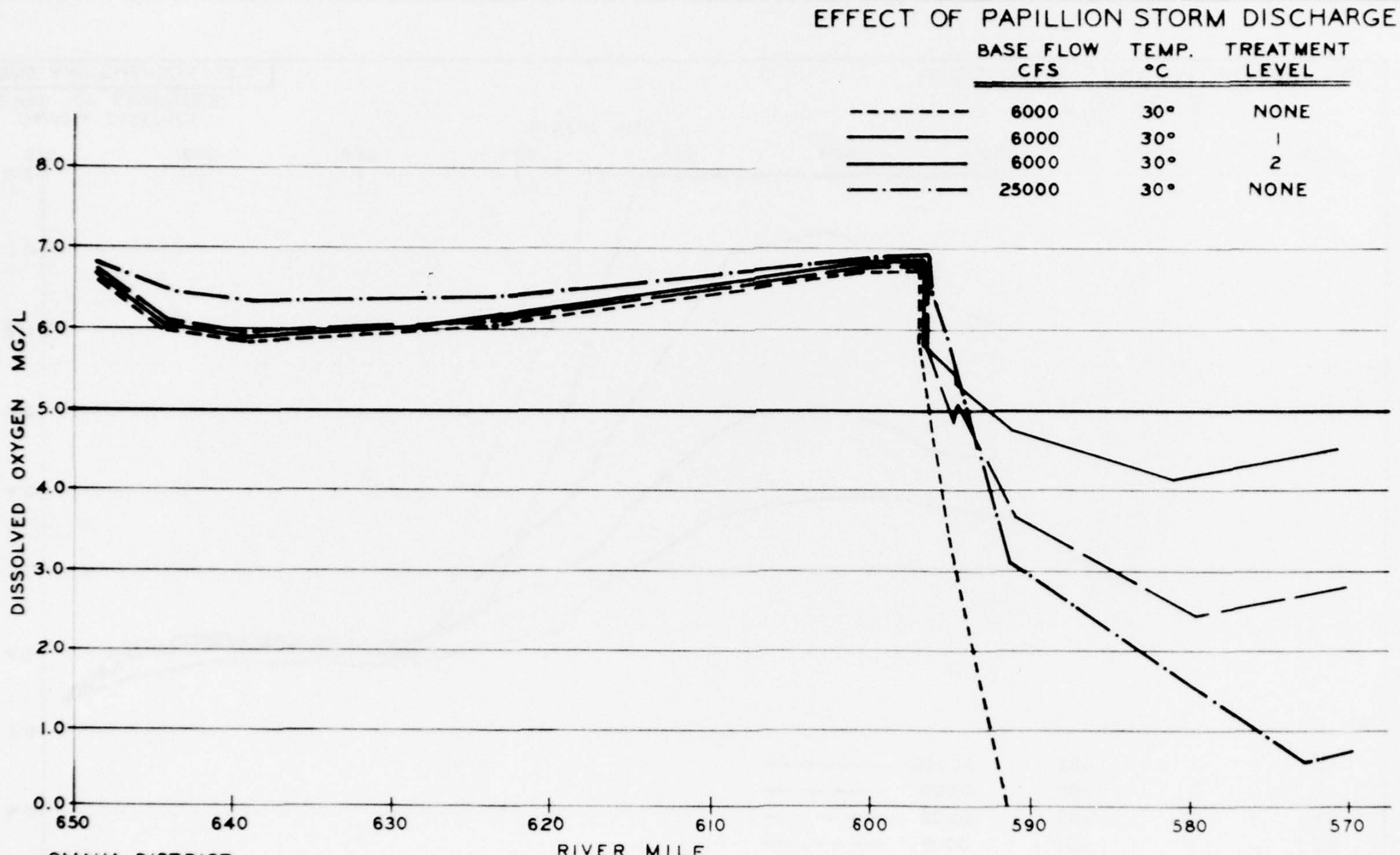

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FIGURE 5
MISSOURI STREAM MODELING

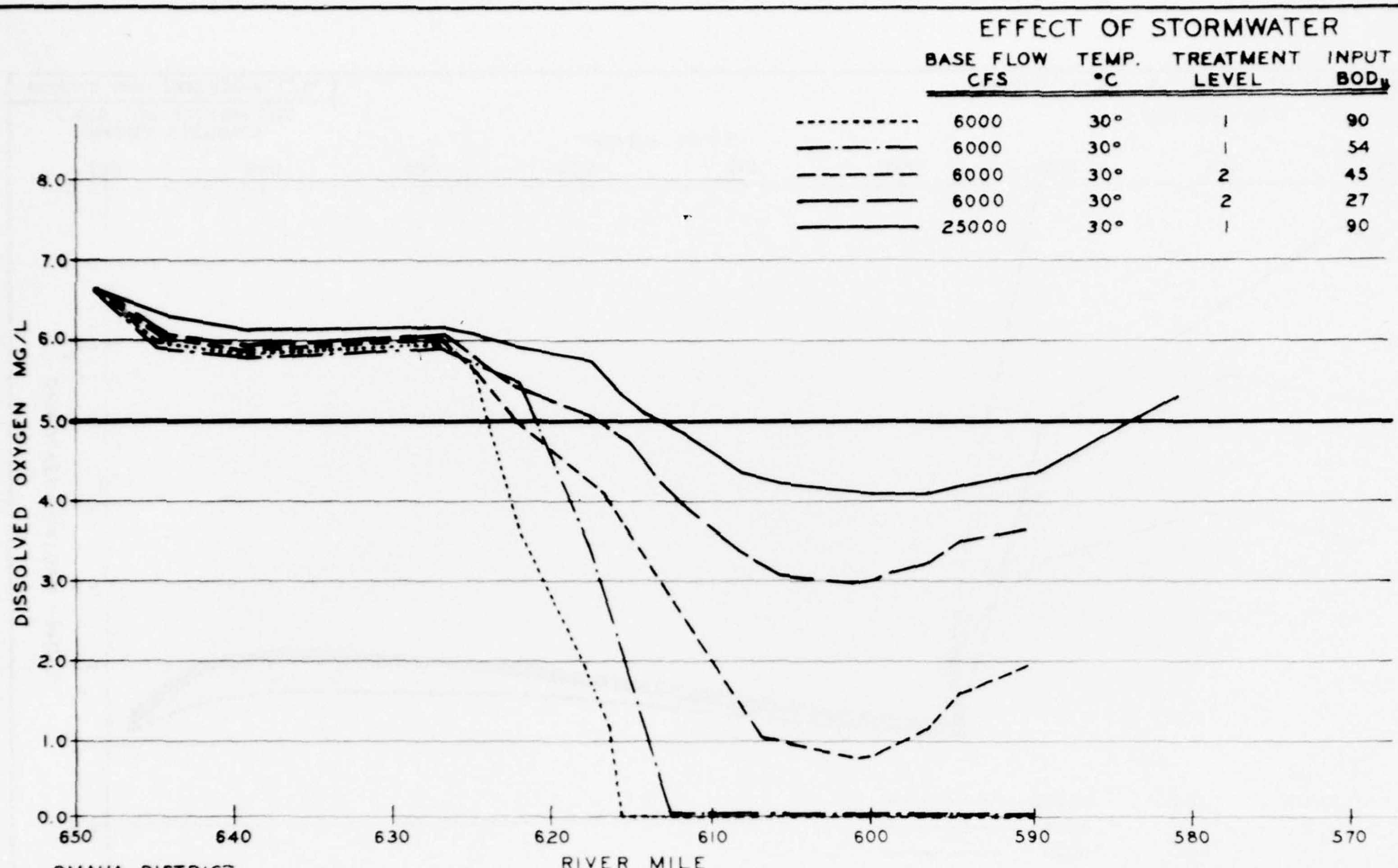

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FIGURE 6
MISSOURI STREAM MODELING

sewer overflows with separate treatment at each location. This represents the effect on the River of the stormwater handling concept in Plans I, II, IV and VIII of Phase I. Because of the uncertainty of the average quality of the overflows, the reduction of BOD by the treatment levels of 40 and 70% (Level 1 and 2, respectively) are based on an influent BOD_5 of both 60 and 100 mg/1, which is considered to be the probable range. The curves corresponding to Level 1 stormwater treatment indicate a serious depletion of DO in the River, even at the higher base flow of 25,000 cfs, although not as serious. The Level 2 treatment curves also show a contravention of standards at critical flow. This treatment level would not be serious at higher flows.

The results shown in the figure indicate that, if multiple treatment and discharge units are used, greater than Level 2 treatment would be required for the extreme condition of 6,000 cfs. Level 1 treatment may be acceptable at the higher flow.

Figure 7 shows a further analysis of the combined sewer overflows. The lower curve corresponds to the use of individual treatment systems which would treat to the zero discharge quality of Phase I. This level is not designed and costed for stormwater but is shown as a comparison with the other levels. At low flow the DO standard is essentially met by this level and at a higher flow would be no problem. The other curve corresponds to the stormwater concept used in Plan III and VII of Phase I. This concept uses a conveyance tunnel with treatment at the Missouri River treatment plant. The result is a 56 cfs continuous, single discharge.

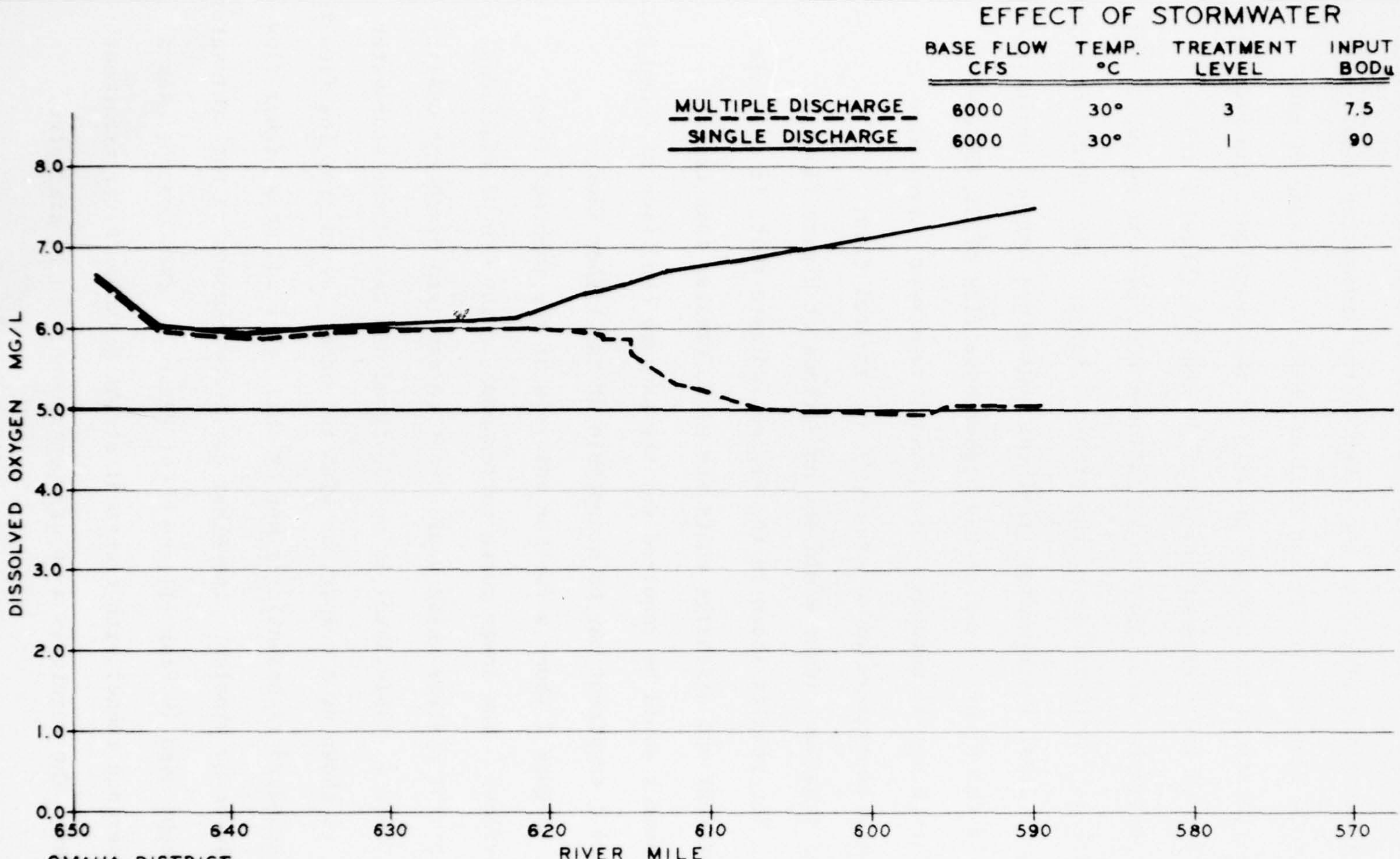

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FIGURE 7
MISSOURI STREAM MODELING

The curve shows that this concept has essentially no impact on the River represented by continued reaeration of the River.

This figure shows that a single discharge combined sewer overflow concept at a minimum level of treatment has a minimum impact on the River. The highest level of treatment using a multiple discharge concept produces a DO sag but meets standards. Further analysis would be required to optimize a combination of the concepts.

Wastewater

Figures 8, 9 and 10 show the effect of wastewater treatment on the critical low flows in the Papillion Creek and Missouri River. The analysis is limited to the Major Urban Plants and Bennington and Elkhorn discharges. The scope of the study precludes modeling of other smaller plants. The planning indicates that only four minor urban plants would discharge to local streams: Bennington, Boystown, Elkhorn and Gretna. Sufficient information for modeling exists for two of these, Bennington and Elkhorn. Results for Boystown and Gretna are inferred from those modeled.

Figure 8 shows the results of the analysis for Bennington and Elkhorn using the low wastewater discharge data derived for Growth Concepts A, C, and D. The figure indicates that Level 1 wastewater treatment is inadequate to meet standards for Elkhorn and Bennington. Level 2 treatment levels are acceptable for Bennington but a slight contravention exists for Elkhorn.

Figure 9 shows that for the higher growth Concept B, both Bennington and Elkhorn would require Level 2 treatment levels to

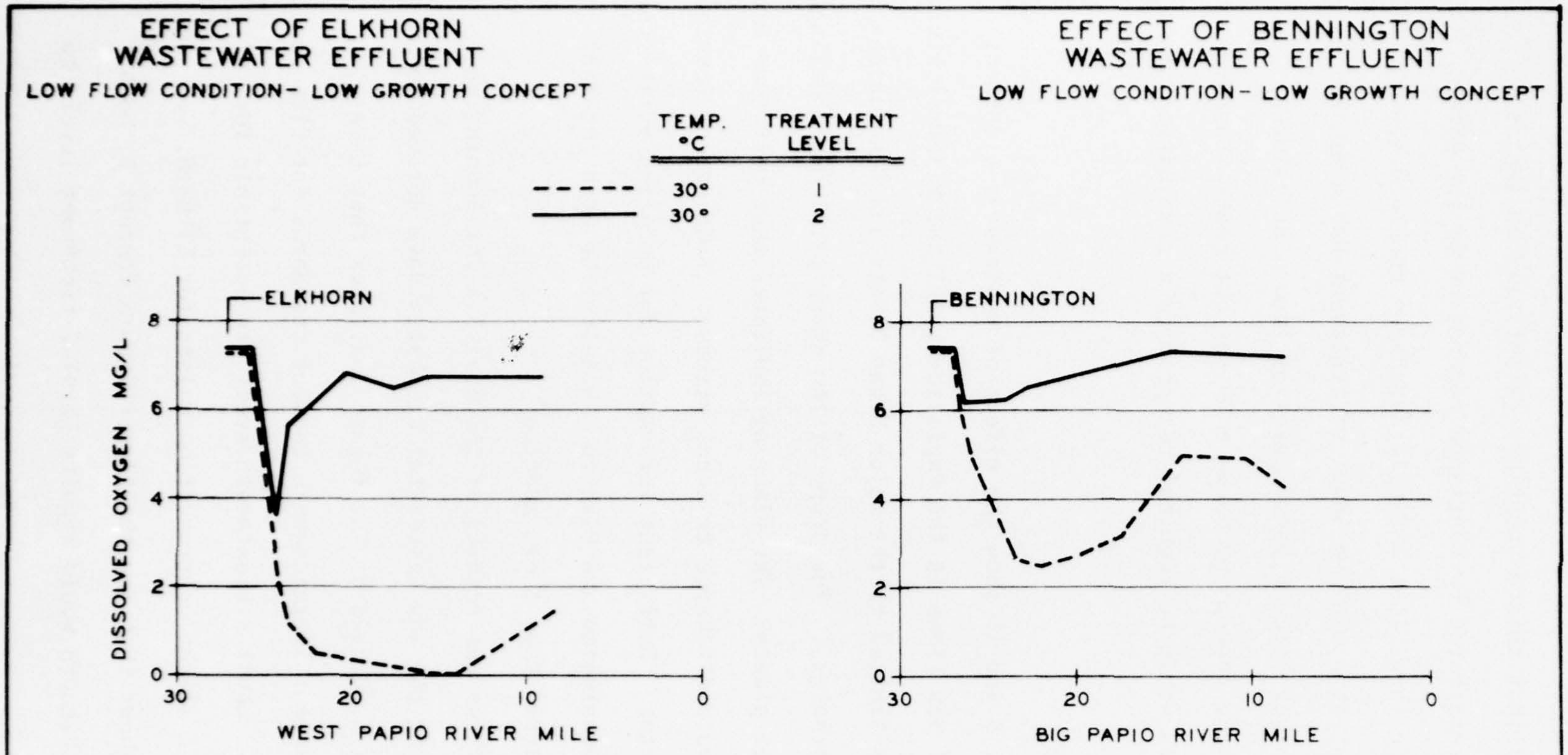

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FIGURE 8
PAPILLION STREAM MODELING

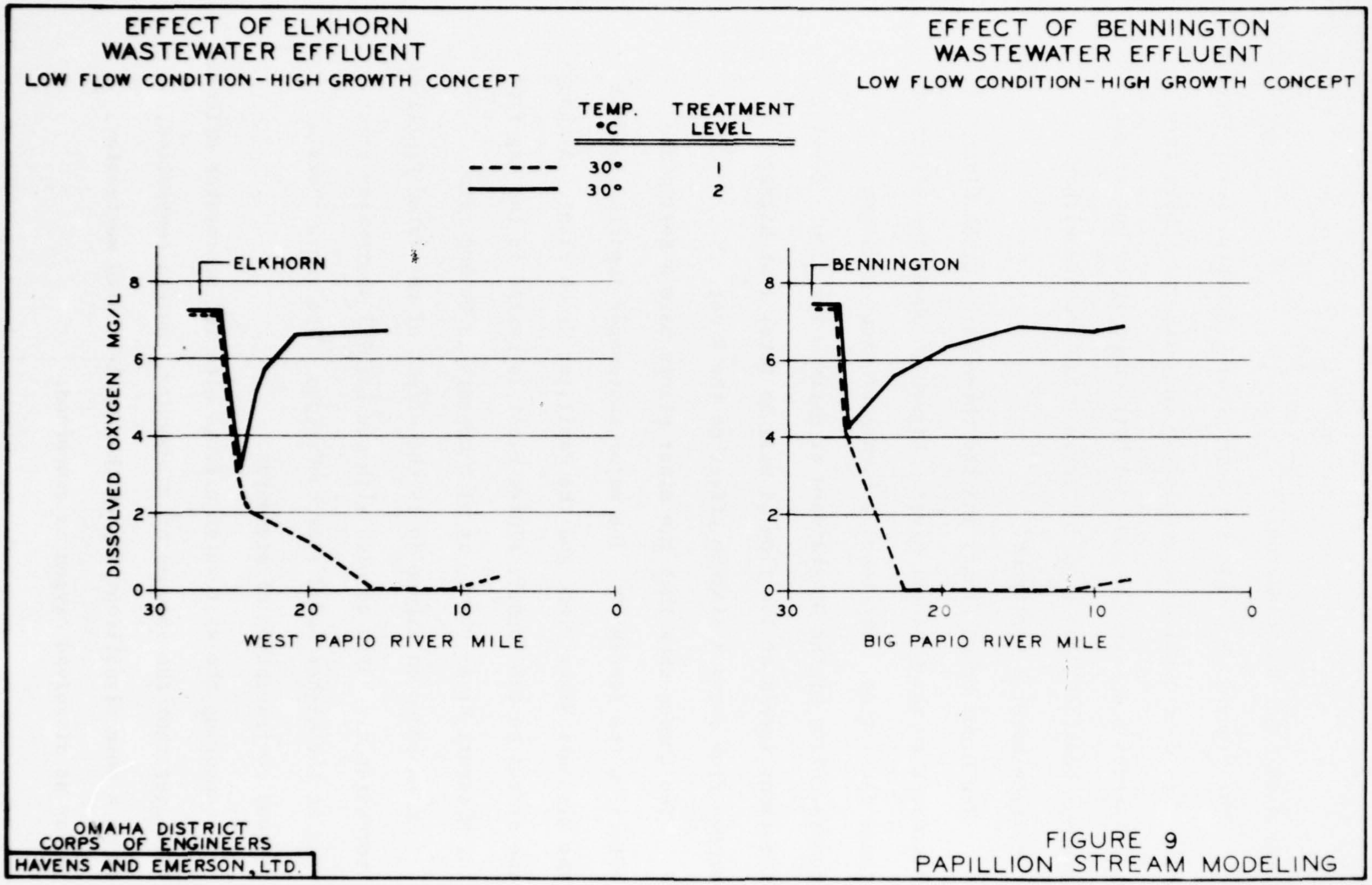

FIGURE 9
PAPILLION STREAM MODELING

stay within the DO standards.

The figures show that for both growth concepts, Level 2 treatment should be applied at Bennington and Elkhorn. Short term contravention appears possible for both communities but slight process modifications should alleviate the problem without requiring Level 3 treatment.

Two Minor Urban Plants and the three Major Urban Plants discharge to the Missouri River. Figure 10 shows the effect of these facilities. The Level 1 treatment shows a slight contravention of the DO standard at extreme low flow. Level 2 treatment levels at low flow as well as Level 1 at higher stream flow shows a minimum effect on the River.

The curves show that the minor plants have a negligible effect on the stream DO. The major wastewater impacts are from the Missouri River Plant and the Papillion Creek Plant. Although the effect on the Council Bluffs plant is masked in the sag from the Missouri River Plant, it also appears to be moderate.

Also shown on Figure 10 is the effect of untreated Papillion stormwater discharge coupled with the Level 1 wastewater treatment at the higher based flow conditions. The curve shows a serious contravention of standards.

Comparing the wastewater effects with the stormwater effects indicates that the volumes of stormwater, unless controlled, cause a more significant impact than well-treated wastewater, so far as dissolved oxygen is concerned.

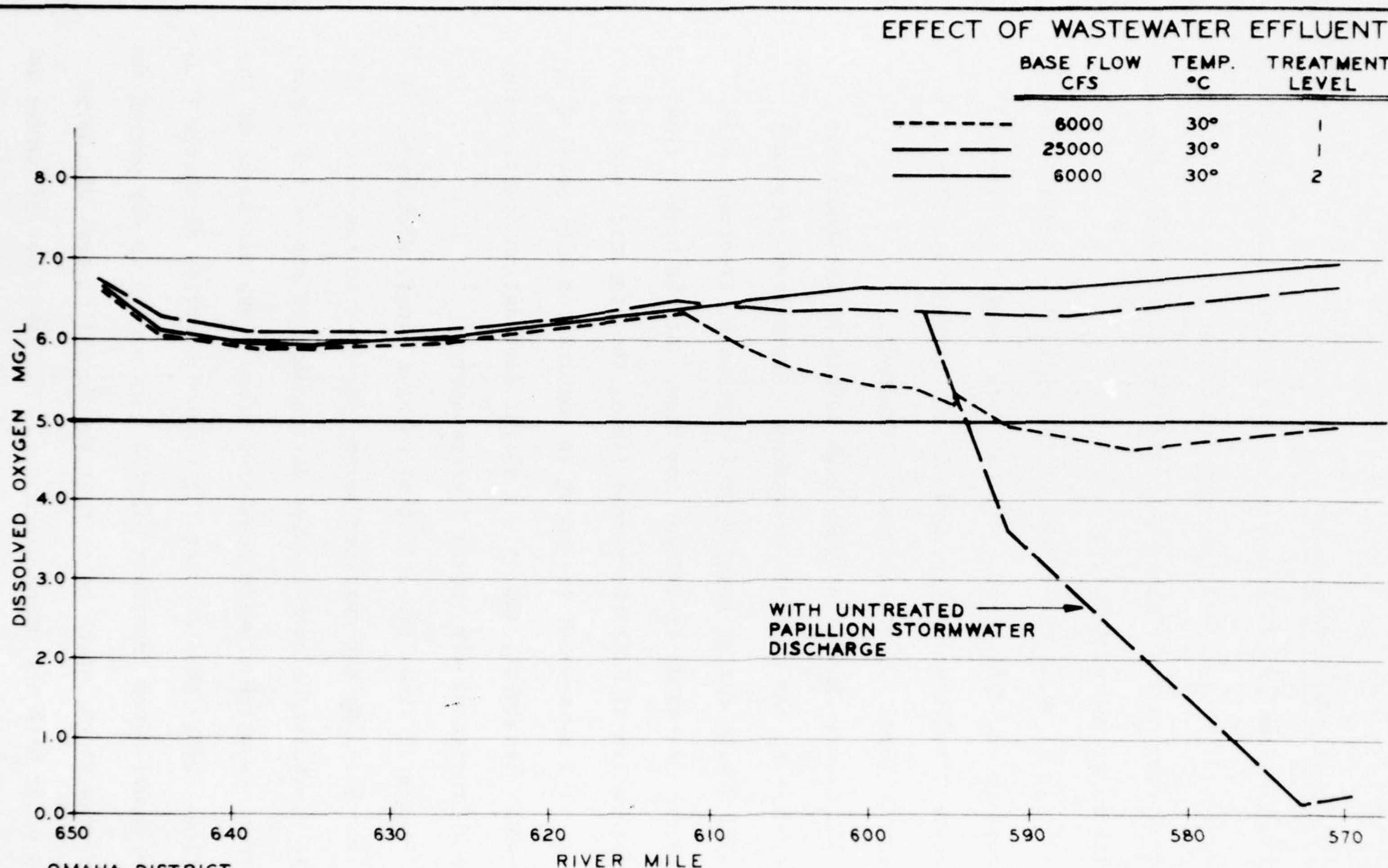

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FIGURE 10
MISSOURI STREAM MODELING

Stormwater with Wastewater

Under actual conditions wastewater effects may occur without stormwater discharges but the opposite cannot occur. Therefore, the following analysis shows the effect of simultaneous discharges of stormwater and wastewater.

Figure 11 shows the effect of the multiple discharge concept of handling combined sewer overflow, with Level 1 and Level 2 wastewater treatment. Also shown is the higher base flow with wastewater Level 2 and stormwater treatment.

The figure shows that very high levels of treatment are required using the multiple discharge. Stormwater treatment to Level 2 with either Level 1 or 2 wastewater treatment will contravene standards at extreme low flow. At the higher flows, representative of historic stream flows, the standards are met with Level 1 wastewater treatment in combination with Level 2 stormwater treatment, and only a slight degradation occurs using Level 1 stormwater with Level 2 wastewater.

Figure 12 shows the effect of using a single discharge concept for handling the combined sewer overflows to the River. The single discharge concept assumes development of one of the Harza alternatives which provide regulated storage and discharge of the overflow. Under this concept the treated overflow discharge from the Missouri River treatment plant occurs over a 20 day period for the design storm, which means that the Papillion peak discharge would occur with the Omaha discharge. The lower set of curves as

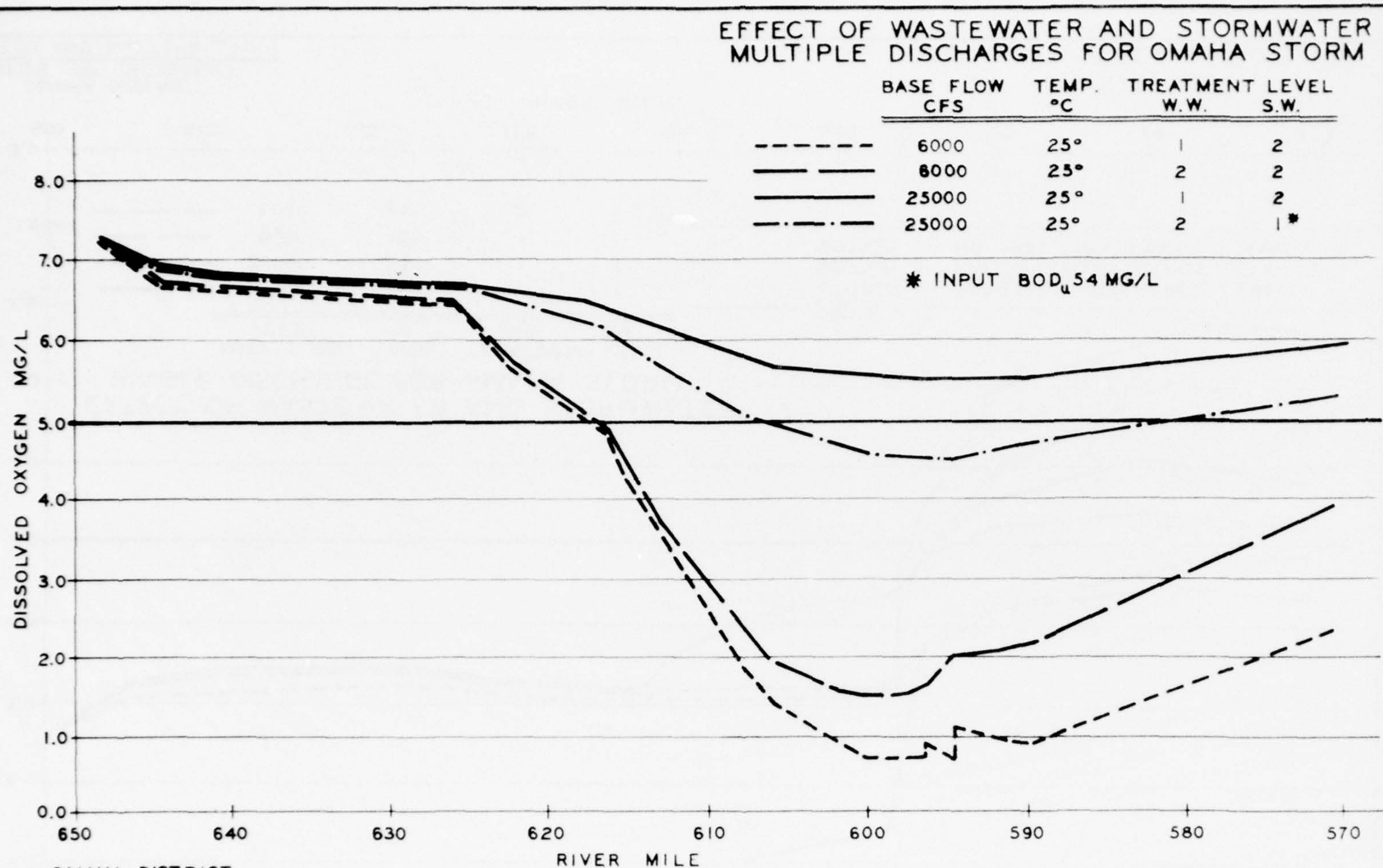

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FIGURE 11
MISSOURI STREAM MODELING

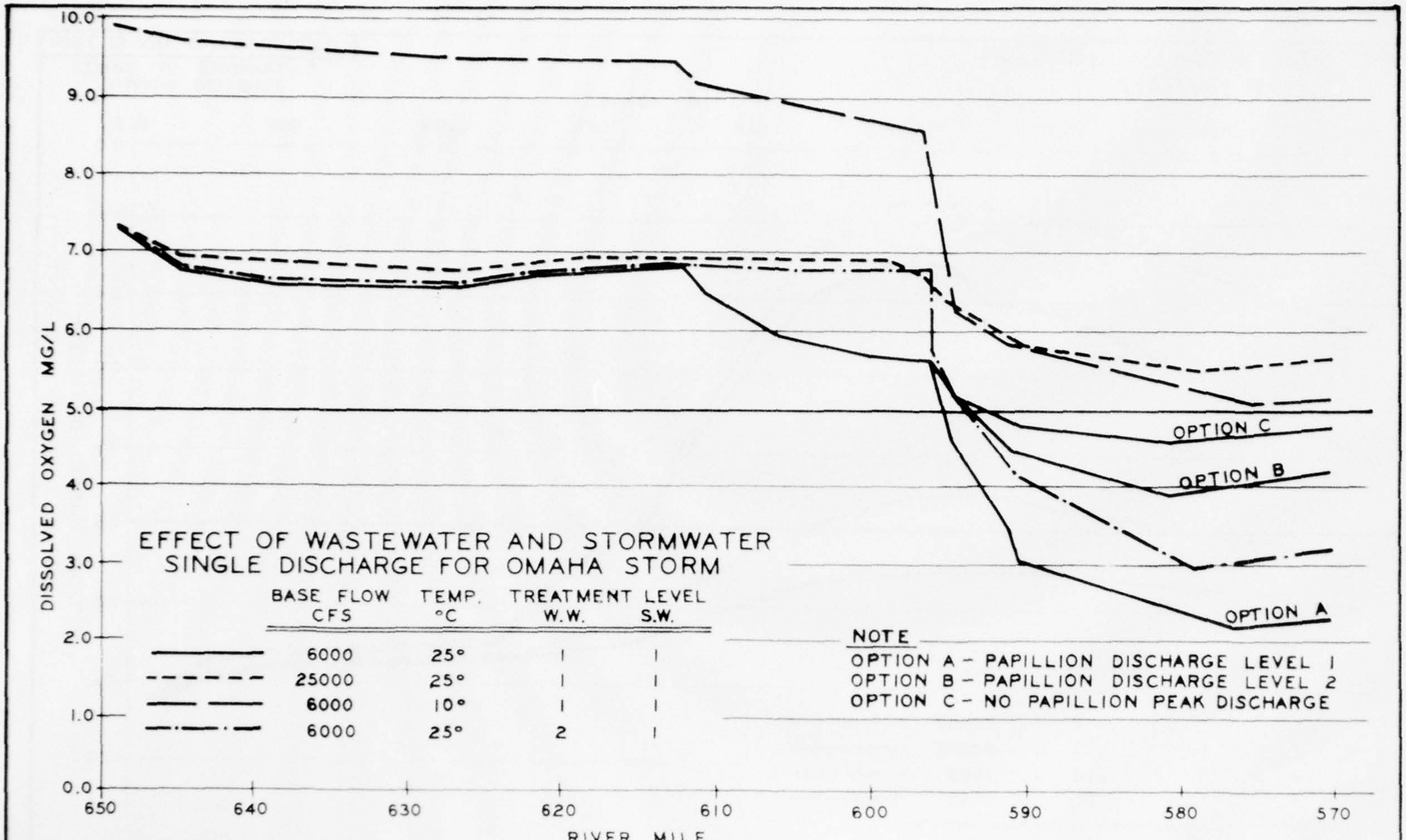

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FIGURE 12
MISSOURI STREAM MODELING

shown by options A, B, and C show the effect of wastewater Level 1 and stormwater Level 1 for direct Missouri River discharges with different Papillion peak discharges corresponding to Level 1 and Level 2 stormwater treatment in the Papillion basin. Also shown in conjunction with this set is the effect on the River with no Papillion peak discharge. The curve representing critical flow, wastewater Level 2 and Papillion stormwater at Level 1 shows a contravention of standards due to the Papillion discharge. The upper two curves indicate that the lower treatment levels will not contravene standards at 10°C or at a base flow of 25,000 cfs.

Conclusions from Stream Modeling

Based on past records the Missouri River flow is at a minimum in the winter and reaches its high in the summer. Using this as a base the curves presented show that the water quality standard for DO will be met at low flow and low temperature, or at high flow and high temperature for Level 1 wastewater treatment quality and Level 1 stormwater quality.

If current planning continues toward upstream diversions of Missouri River water in the summer, then a low flow - high temperature situation could control. Under this combination the curves indicate that effluent quality requirements for wastewater and stormwater must be increased to Level 2 for both, using a single stormwater discharge concept for the Missouri River overflows. Higher levels would be required using a Multiple discharge.

The figures concerning wastewater discharges at low flow conditions in the Papillion Creek show that Level 2 wastewater

treatment is required to maintain the DO standard. A slight contravention of standards occurs for Elkhorn even with Level 2 wastewater but this is uncertain pending verification of the model and is not considered serious.

It should be noted that these conclusions are based on a preliminary modeling of the Missouri River, limited to the reach downstream of Blair, and made upon simplifying assumptions as to water quality entering the reach. These results should be verified by more detailed modeling studies of the entire Missouri before final committment of plan implementation is made.

COST EFFECTIVENESS

Treatment Levels

The preceding section on Stream Modeling indicates the immediate water quality impacts on the Missouri River and Papillion Creek due to various levels of treatment of wastewater and stormwater and certain combinations of critical low flows and temperatures. Another approach to evaluate water quality impacts is to consider total pollutant reduction on an annual basis. This section develops a comparison of present worth costs required to achieve various reductions in pollutant parameters as influenced by the various treatment levels of wastewater and stormwater.

The following figures were developed for Plan 1, Concept A of Phase I, for various levels of treatment and 1995 annual pollutants reduction. Basic references are Table C-9 for Present Worth costs and Table C-11 for pollutants reduction in the Phase I report.

The suspended solids curve, Figure 13, illustrates that in order to achieve substantial reduction, stormwater treatment must be employed. Levels of wastewater treatment have negligible effects.

The BOD curve, Figure 14, illustrates that the variation in reduction is relatively small (90.6% to 96.9%), for the increased levels of wastewater and stormwater treatment.

The phosphorus curve, Figure 15, shows significant reduction from Level 1 to Level 2 wastewater. Stormwater reductions are negligible for phosphorus.

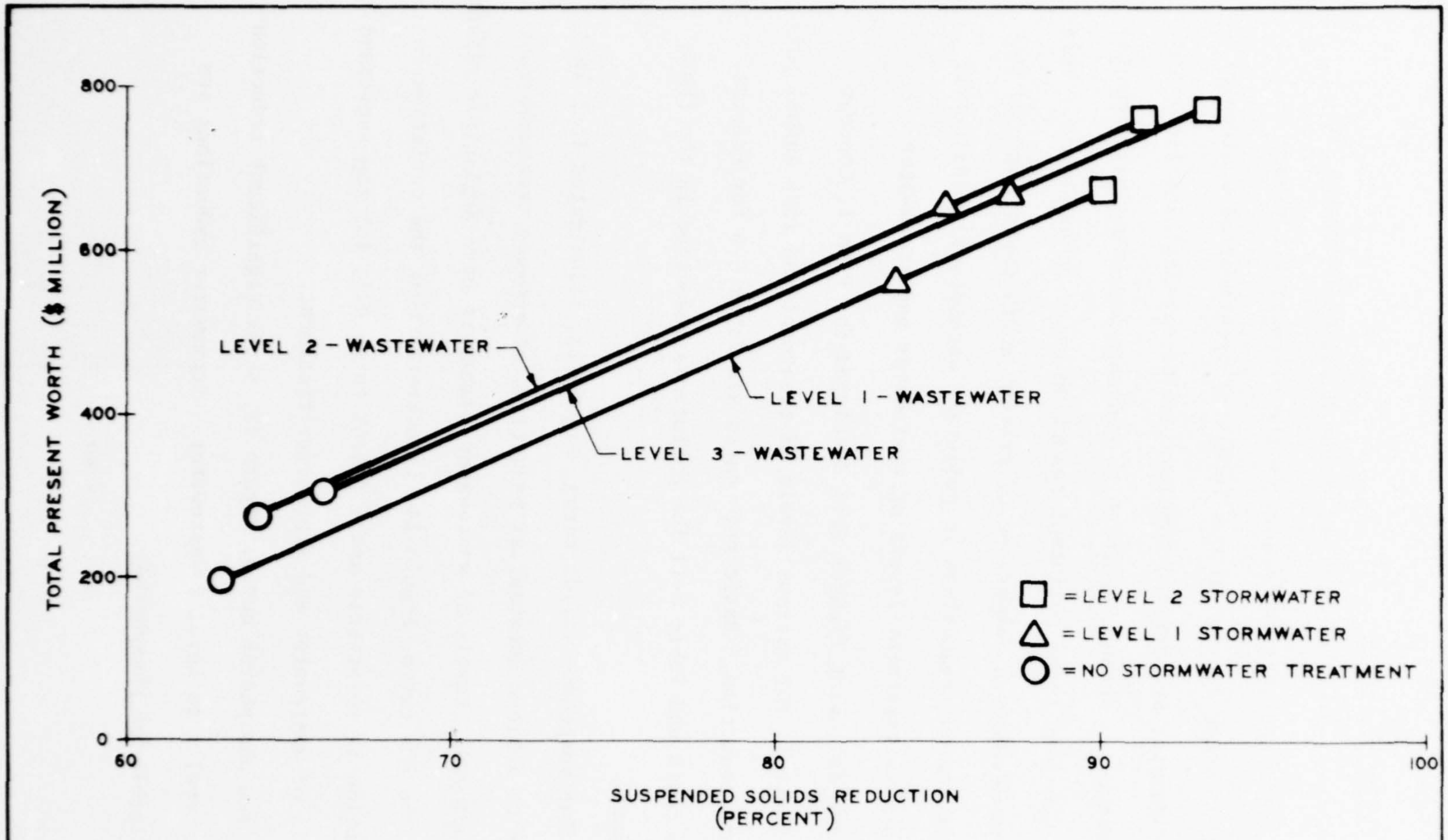

FIGURE 13
COST EFFECTIVENESS

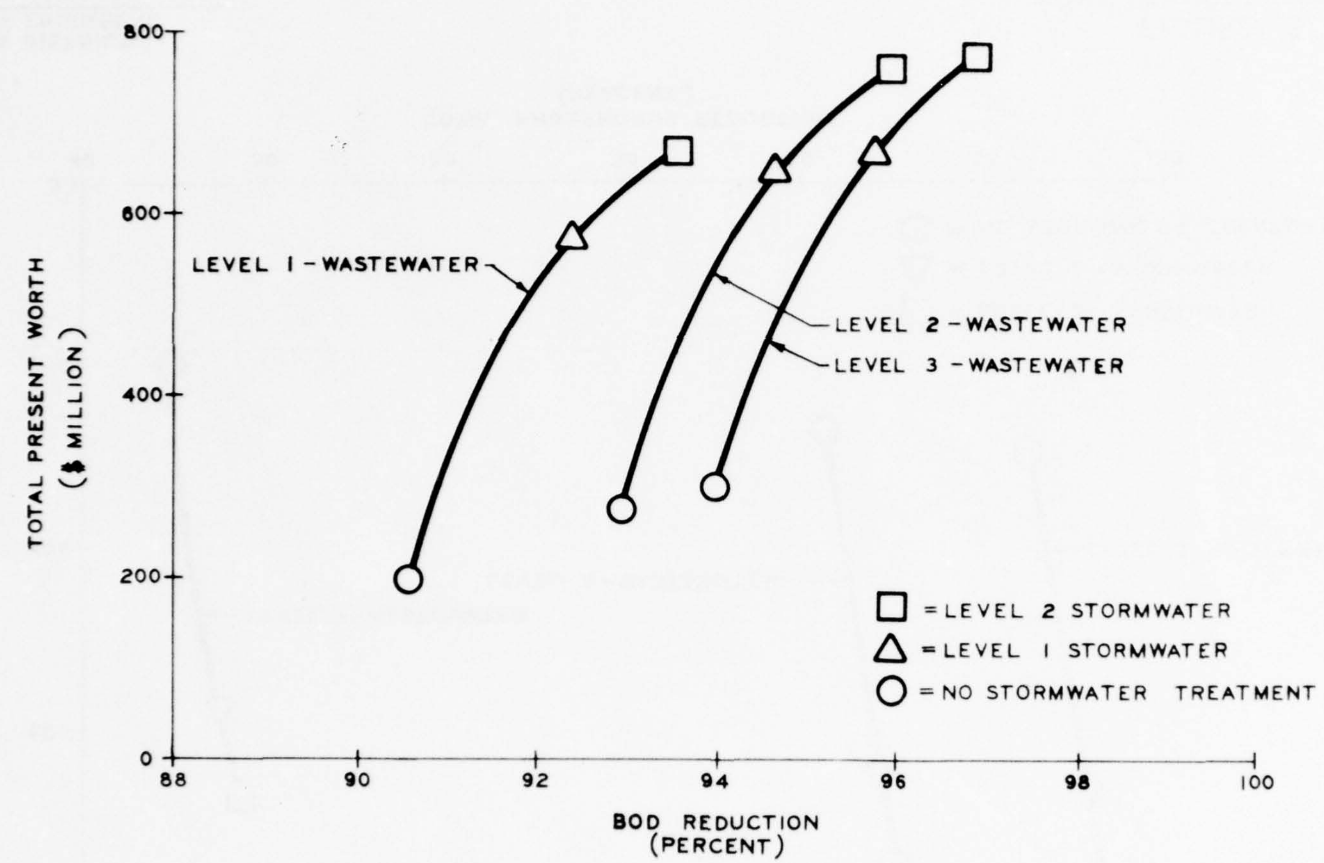

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FIGURE 14
COST EFFECTIVENESS

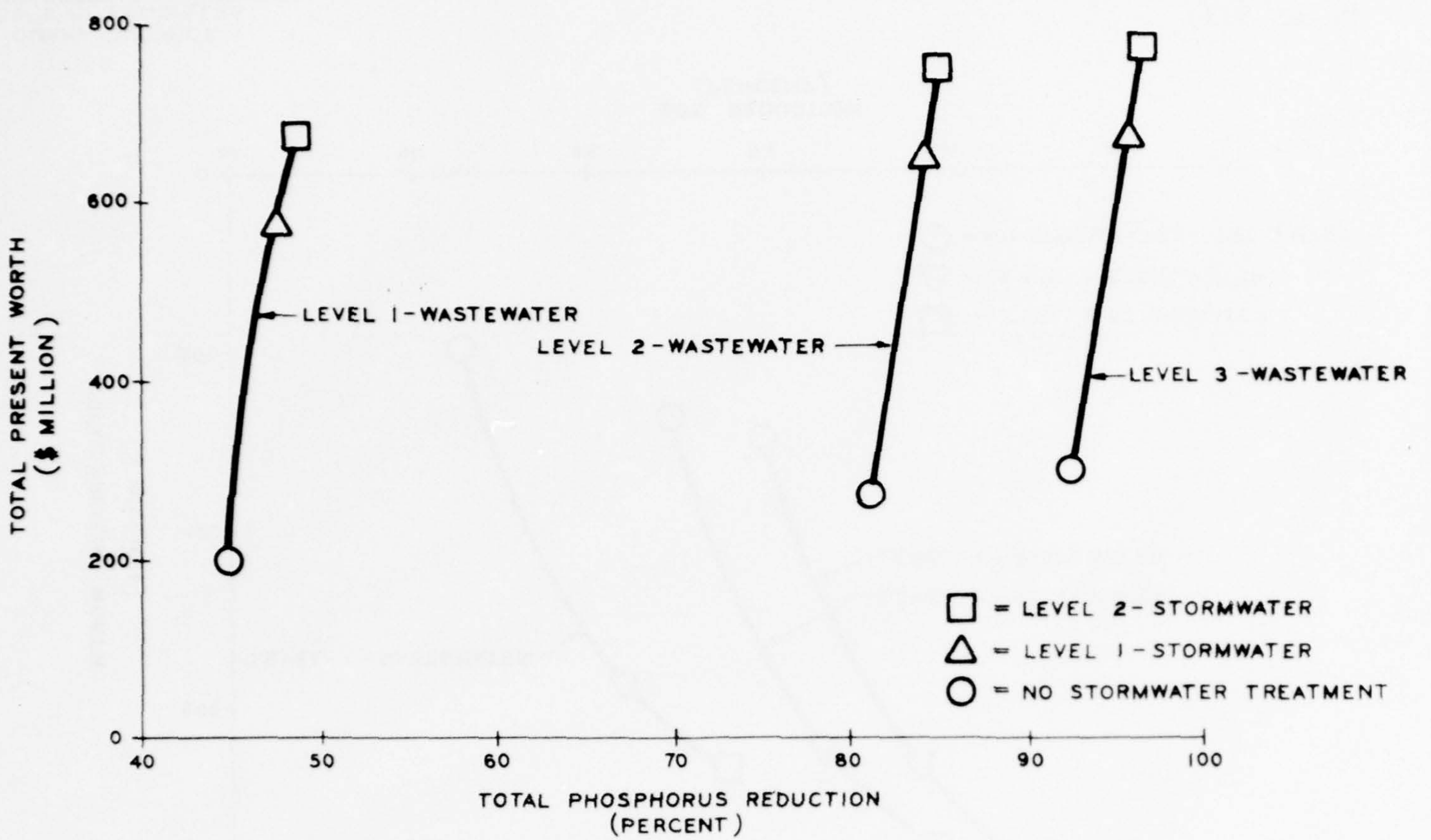

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FIGURE 15
COST EFFECTIVENESS

The nitrogen curve, Figure 16, shows significant reduction from Level 2 to Level 3 wastewater. The curve is misleading due to the fact that Level 2 wastewater does provide nitrification which is not given any credit.

The overall pollutant reduction curve, Figure 17, applies equal weight to each of the four parameters mentioned. It shows that treatment of wastewater to higher levels is more cost effective than stormwater treatment. A problem with this presentation is that there are other pollutants (bacteria, gross solids, etc.) associated with urban runoff, separate and combined, which are not accounted for in this cost effective analysis.

The curves indicate that, with the exception of suspended solids, the pollutant parameters are more effectively reduced by upgrading wastewater effluents than by stormwater treatment. This generalization applies only to the total annual inputs and could be somewhat misleading especially with no treatment of stormwater. In an individual storm situation some treatment for floating material and bacterial contamination appears desireable.

Design Storms

The costs of stormwater treatment as illustrated in the Plan Present Worth Summary tables are the major component of the total costs. The cost increases are also illustrated for the different design storms in Figure 18. The magnitude of the monies needed for stormwater treatment may in itself alter the implementation of such a program. This particular discussion is not meant,

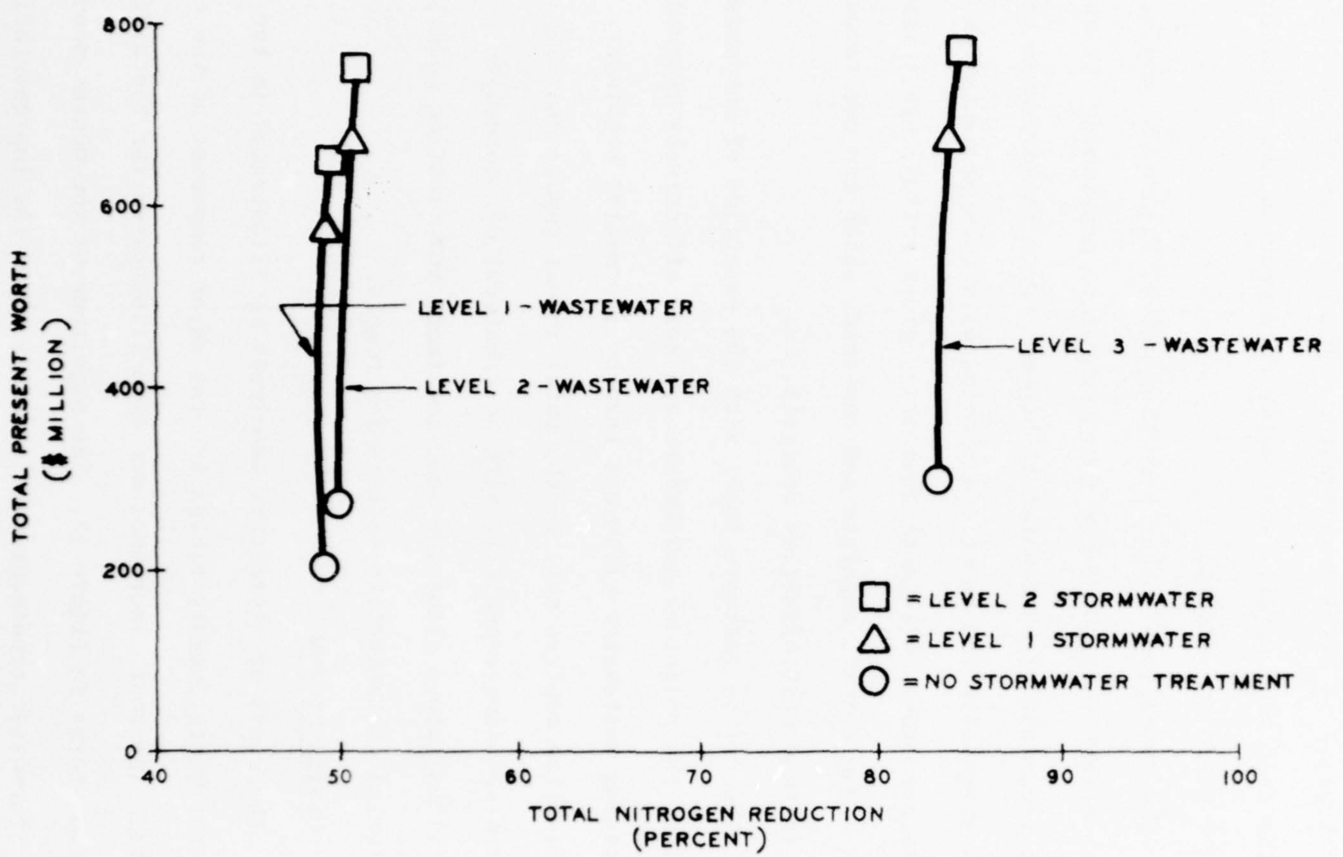

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FIGURE 16
COST EFFECTIVENESS

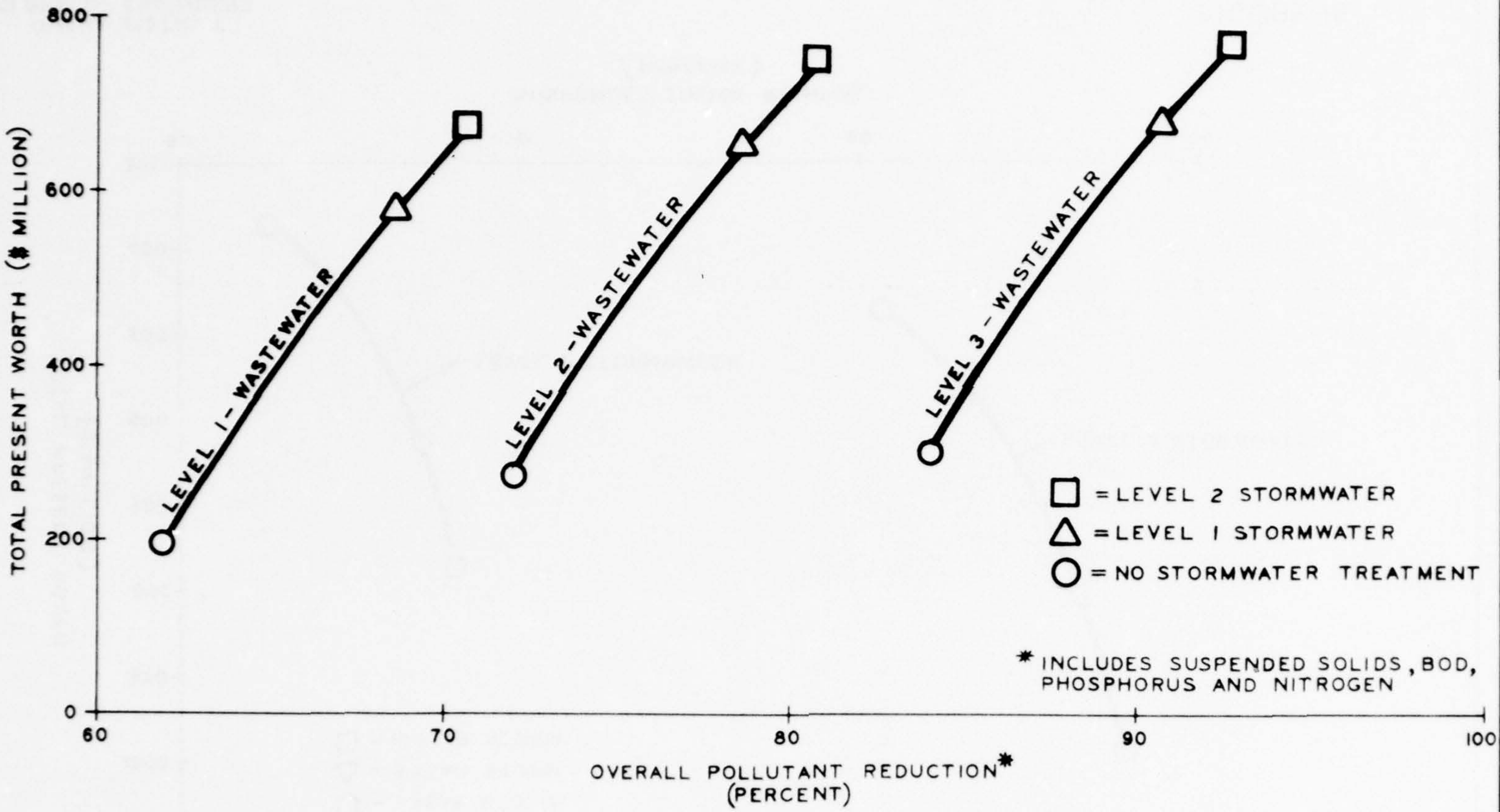

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FIGURE 17
COST EFFECTIVENESS

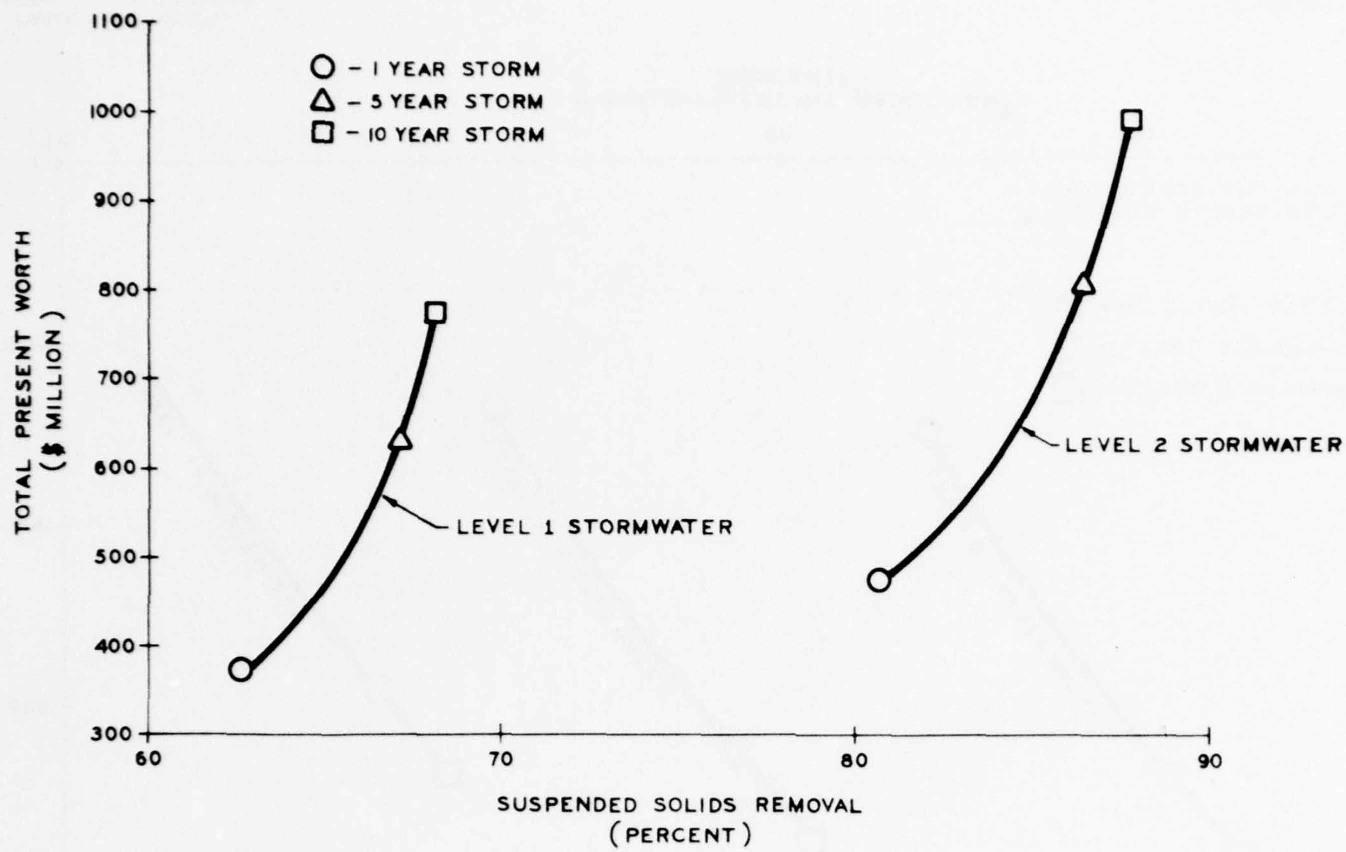

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FIGURE 18
COST EFFECTIVENESS

however, to discuss the merits of stormwater treatment but rather the comparison of the 1, 5 and 10 year storm design. Figure 18 illustrates the decrease in cost effectiveness as the design storm facilities are increased from the 1 to the 5 to the 10 year design storm. The relatively slight increase in total suspended solids removed results in a considerable increase in dollars spent. The 1 year storm is therefore recommended as the maximum recurrence interval which should be considered for stormwater facility design.

Conclusion

The previous figures show how the stream DO and plan costs are affected by various treatments. Generally the costs indicate that, based on total annual load reductions, wastewater treatment more effectively reduces pollutants than stormwater treatment. However, the DO curves show that the short-term effects of stormwater runoff and combined sewer overflows for an individual one year storm are detrimental to the streams. This information will be used by the Corps in the environmental analysis portion of the Urban Study.

D. PHASE II ALTERNATIVE PLANS

PLAN FORMULATION

Constraints

After consideration of the findings of the Phase I report, further analysis of the eight alternatives, and the receipt of input from the Interagency Council, guidelines were developed for the final alternatives.

1. Conveyance of all stormwater to municipal plants should not be considered as a full alternate.
2. Handling of stormwater by land treatment was eliminated as not cost-effective.
3. Three major urban plants would remain.
4. Bellevue would be incorporated into the Papillion STP.
5. Continue consideration of three treatment levels for wastewater and two for stormwater but give emphasis to lower levels.
6. Continue consideration of all four growth concepts.
7. Analyze conveyance for combined sewer areas.
8. Retain a land treatment plan.
9. Consider summer irrigation from the Major Urban Plants to avoid winter storage and pumping.
10. Refine phasing on the land treatment systems.
11. Meet water quality DO standards in all final plans.
12. Use the one-year design storm in the design of all stormwater handling facilities.

Plan Description

Three full alternative plans and a Major Land Treatment Option are developed in this chapter based on the results of the Phase I study and subsequent work.

The three plans basically follow the wastewater layout for the lowest cost plans presented in Phase I; namely, Plan I, Plan II and Plan VII. Stormwater collection and treatment is accomplished the same for each plan. However, both upsystem treatment and conveyance to the municipal plant for treatment are used within the refined plans. For all plans, the conveyance system proposed by Harza (5A) is used for the Missouri combined sewer overflows. This conveyance system for the Omaha combined sewer area appears to be more cost-effective than the upsystem treatment alternative. Upsystem treatment is used, however, in the remainder of the basins although a sub-alternative is presented for conveyance of two combined sewer areas in the Papillion Basin and one combined sewer area in Council Bluffs to the municipal wastewater treatment plants. Each plan is costed for the one-year design storm and all treatment levels. Level 1 stormwater is associated with both Level 1 and Level 2 wastewater, and Level 2 stormwater is associated with Level 3 wastewater.

The Major Land Option is developed to analyze the possibilities of using the urban wastewater effluent during the summer months in the large agricultural areas west of the

study area. Several sub-options are considered using different treatment sites and flows. These options present costs using five-year phasing for all components required for land treatment systems. The option costs can be applied to any of the plans but the concept conforms more closely to Plan 3 which envisions small land systems for the Minor and Non-Urban facilities.

COMMON FEATURES

Certain features remain constant between plans. The component costs associated with these features are presented in this section and are not repeated except for totals in the discussion of specific plans.

These features include:

Stormwater treatment

Non-Urban wastewater treatment

Minor urban wastewater treatment

Stormwater Treatment

The stormwater handling techniques used in Phase II provide generally for upsystem treatment and discharge of all stormwater generated by a one-year storm. The Omaha combined sewer overflows are a major departure from this concept. For this area, a method of conveyance and storage is provided to reduce the peak flow and number of overflows to the River. The Harza Combined Sewer Overflow study presents various alternatives which fit this pattern. The costs used for this purpose are based on Harza's Alternative 5A.

Tables 30 and 31 show the capital costs for the stormwater treatment in each concept for Levels 1 and 2, respectively. These costs include the collectors required to tie existing systems in to the basin. In non-developed areas the storm collection system to the basin is not included, but would be incorporated in development costs. The tables also show the

TABLE 30

STORMWATER
CAPITAL SUMMARY COSTS (PHASED)
1 YEAR STORM, LEVEL 1 TREATMENT
CONCEPT A
(x $1,000)

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	8,423	3,623	0	8,442	4,610	3,528
Concrete	0	0	0	78,432	3,310	9,152	56,088	1,850	0
Concrete Combined	51,186	2,120	3,040	0	0	0	0	0	0
Total	51,186	2,120	3,040	86,855	6,933	9,152	64,530	6,460	3,528
OMAHA									
Earth	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	99,760	21,840	0	0	0	0	0	0	0
Total	99,760	21,840	0	0	0	0	0	0	0
COUNCIL BLUFFS									
Earth	0	0	0	1,008	900	4,943	1,658	1,413	7,750
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	9,576	240	0	0	0	0	0	0	0
Total	9,576	240	0	1,008	900	4,943	1,658	1,413	7,750
OTHERS									
Earth	0	0	0	725	630	1,240	850	1,445	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	0	0	0	0	0	0	0	0	0
Total	0	0	0	725	630	1,240	850	1,445	0

TABLE 30 (CONT'D.)

STORMWATER
CAPITAL SUMMARY COSTS (PHASED)
1 YEAR STORM, LEVEL 1 TREATMENT
CONCEPT B
(x $1,000)

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	6,725	3,110	0	2,134	1,535	3,528
Concrete	0	0	0	96,558	3,760	9,616	38,760	1,540	0
Concrete Combined	54,264	2,200	2,893	0	0	0	0	0	0
Total	54,264	2,200	2,893	103,283	6,870	9,616	40,894	3,075	3,528
OMAHA									
Earth	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	99,760	21,840	0	0	0	0	0	0	0
Total	99,760	21,840	0	0	0	0	0	0	0
COUNCIL BLUFFS									
Earth	0	0	0	1,209	1,060	5,809	4,280	1,318	9,602
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	9,348	235	0	0	0	0	0	0	0
Total	9,348	235	0	1,209	1,060	5,809	4,280	1,318	9,602
OTHERS									
Earth	0	0	0	650	580	1,630	2,208	2,430	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	0	0	0	0	0	0	0	0	0
Total	0	0	0	650	580	1,630	2,208	2,430	0

TABLE 30 (CONT'D.)

STORMWATER
CAPITAL SUMMARY COSTS (PHASED)
1 YEAR STORM, LEVEL 1 TREATMENT
CONCEPT C
(x $1,000)

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	6,936	3,150	0	4,204	2,335	3,528
Concrete	0	0	0	76,608	3,230	9,151	60,078	2,060	0
Concrete Combined	42,978	1,846	2,769	0	0	0	0	0	0
Total	42,978	1,846	2,769	83,544	6,380	9,151	64,282	4,395	3,528
OMAHA									
Earth	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	99,760	21,840	0	0	0	0	0	0	0
Total	99,760	21,840	0	0	0	0	0	0	0
COUNCIL BLUFFS									
Earth	0	0	0	897	840	4,943	1,057	987	7,340
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	9,006	230	0	0	0	0	0	0	0
Total	9,006	230	0	897	840	4,943	1,057	987	7,340
OTHERS									
Earth	0	0	0	462	450	1,105	1,145	1,562	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	0	0	0	0	0	0	0	0	0
Total	0	0	0	462	450	1,105	1,145	1,562	0

TABLE 30 (CONT'D.)

STORMWATER
CAPITAL SUMMARY COSTS (PHASED)
1 YEAR STORM, LEVEL 1 TREATMENT
CONCEPT D
(x $1,000)

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	9,549	3,630	0	6,718	4,062	3,528
Concrete	0	0	0	83,562	3,443	7,536	32,604	2,090	0
Concrete Combined	40,584	1,760	2,907	0	0	0	0	0	0
Total	40,584	1,760	2,907	93,111	7,073	7,536	39,322	6,152	3,528
OMAHA									
Earth	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	99,760	21,840	0	0	0	0	0	0	0
Total	99,760	21,840	0	0	0	0	0	0	0
COUNCIL BLUFFS									
Earth	0	0	0	1,229	1,050	6,550	1,837	1,533	7,948
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	8,436	220	0	0	0	0	0	0	0
Total	8,436	220	0	1,229	1,050	6,550	1,837	1,533	7,948
OTHERS									
Earth	0	0	0	777	680	3,620	1,030	1,435	0
Concrete	0	0	0	0	0	0	0	0	0
Concrete Combined	0	0	0	0	0	0	0	0	0
Total	0	0	0	777	680	3,620	1,030	1,435	0

TABLE 31

STORMWATER CAPITAL COSTS (PHASED)
(x $1,000)
1 YEAR STORM, LEVEL 2

CONCEPT A

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	8,423	17,110	0	8,442	19,870	3,528
Concrete	0	0	0	86,275	15,000	9,152	61,697	8,800	0
Concrete (Combined)	56,305	10,400	3,040	0	0	0	0	0	0
TOTAL	56,305	10,400	3,040	94,698	32,110	9,152	70,139	28,670	3,528

CONCEPT B

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	6,582	13,500	0	2,008	5,100	3,528
Concrete	0	0	0	106,213	17,600	9,616	42,636	6,400	0
Concrete (Combined)	56,690	10,600	2,893	0	0	0	0	0	0
TOTAL	56,690	10,600	2,893	112,795	31,100	9,616	44,644	11,500	3,528

CONCEPT C

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	6,838	14,400	0	2,410	6,380	3,528
Concrete	0	0	0	84,629	14,800	9,151	66,086	10,150	0
Concrete (Combined)	47,276	8,600	2,769	0	0	0	0	0	0
TOTAL	47,276	8,600	2,769	91,467	29,200	9,151	68,496	16,530	3,528

CONCEPT D

	1980			1985			1995		
	Storage	Treatment	Collector	Storage	Treatment	Collector	Storage	Treatment	Collector
PAPILLION									
Earth	0	0	0	9,549	16,100	0	6,289	15,220	3,528
Concrete	0	0	0	91,918	15,100	9,616	70,851	8,600	0
Concrete (Combined)	44,642	14,200	2,907	0	0	0	0	0	0
TOTAL	44,642	14,200	2,907	101,467	31,200	9,616	77,140	23,820	3,528

costs for both concrete and earth stormwater basins. The concrete combined values indicate only the combined overflow systems. Two such basins are included in the Papillion basin, one in Council Bluffs and the conveyance system for Omaha. Tables 32 and 33 show the O & M costs associated with the stormwater system for Levels 1 and 2, respectively. The 1980 values are associated with combined sewer overflows. The total present worths of the components are shown in Tables 34 and 35. The stormwater system costs presented here apply to the three final alternative plans and are not repeated for each. The values show that the costs of stormwater treatment vary significantly with growth concept.

The capital costs associated with the sewer systems when the combined sewer basins are conveyed to the wastewater treatment plants are shown in Table 36, as compared to the capital costs of the sewer systems with sanitary wastewater only. The Δ cost shows the difference. This reflects the cost attributed to the combined basins emptying into the Papillion System, and combined basin emptying into the Council Bluffs System, as shown on Plates 5, 6, and 7. The rates of discharge were calculated using a 1-year storm entering the basin and a discharge time period of 3 days.

TABLE 32

STORMWATER O&M SUMMARY COSTS (PHASED)
(x $1,000)
1 YEAR STORM LEVEL 1

	Concept A				Concept B				Concept C				Concept D			
	1980	1985	1995	2020	1980	1985	1995	2020	1980	1985	1995	2020	1980	1985	1995	2020
PAPILLION																
Earth	0	184	489	722	0	233	373	396	0	215	325	370	0	491	778	942
Concrete	0	190	341	355	0	207	355	356	0	215	601	969	0	233	389	422
Concrete (Combined)	146	147	151	157	136	139	142	149	133	134	138	138	136	139	142	149
TOTAL	146	521	981	1,234	136	579	870	901	133	564	1,064	1,477	136	863	1,309	1,513
OMAHA																
Earth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete (Combined)	479	515	580	581	468	504	543	573	487	532	617	627	474	507	567	589
TOTAL	479	515	580	581	468	504	543	573	487	532	617	627	474	507	567	589
COUNCIL BLUFFS																
Earth	0	41	122	137	0	40	144	148	0	74	114	120	0	40	116	169
Concrete	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete (Combined)	21	21	23	23	20	20	21	22	20	20	20	21	21	21	23	24
TOTAL	21	62	145	160	20	60	165	170	20	94	134	141	21	61	139	193
OTHERS																
Earth	0	30	46	79	0	27	147	157	0	27	65	74	0	31	75	87
Concrete	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Concrete (Combined)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	30	46	79	0	27	147	157	0	27	65	74	0	31	75	87

TABLE 33

STORMWATER
O & M COSTS FOR PAPILLION (PHASED)
(x $1,000/yr)
1 Year Storm, Level 2

	1980	1985	1990	1995	2020
Concept A					
Papillion Earth	0	329	602	876	1,290
Papillion Concrete	0	295	415	534	544
Papillion Concrete (Combined)	227	231	235	235	247
Total	227	855	1,252	1,645	2,081
Concept B					
Papillion Earth	0	417	544	667	708
Papillion Concrete	0	323	439	554	554
Papillion Concrete (Combined)	227	231	235	235	247
Total	227	971	1,218	1,456	1,509
Concept C					
Papillion Earth	0	385	485	582	664
Papillion Concrete	0	335	638	937	1,511
Papillion Concrete (Combined)	207	211	215	215	215
Total	207	931	1,338	1,734	2,390
Concept D					
Papillion Earth	0	879	1,137	1,393	1,684
Papillion Concrete	0	363	486	606	658
Papillion Concrete (Combined)	211	215	219	223	231
Total	211	1,457	1,842	2,222	2,573

TABLE 34

STORMWATER PRESENT WORTH COSTS
(x $1,000)
1 YEAR STORM LEVEL 1

	Concept A			Concept B			Concept C			Concept D		
	Capital	O & M	Total	Capital	O & M	Total	Capital	O & M	Total	Capital	O & M	Total
PAPILLION												
Earth	12,735	3,524	16,259	8,455	2,619	11,074	9,489	2,358	11,847	12,751	5,685	18,436
Concrete	74,150	2,334	76,484	80,765	2,422	83,187	74,218	4,448	78,666	67,089	2,721	69,810
Concrete (Combined)	49,950	1,676	51,626	52,621	1,676	54,297	42,192	1,520	43,712	40,112	1,572	41,684
TOTAL	136,835	7,534	144,369	141,841	6,717	148,558	125,899	8,326	134,225	119,952	9,978	129,930
OMAHA												
Earth	0	0	0	0	0	0	0	0	0	0	0	0
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
Concrete (Combined)	109,508	6,041	115,549	109,508	5,830	115,338	109,508	6,345	115,854	109,508	5,965	115,473
TOTAL	109,508	6,041	115,549	109,508	5,830	115,338	109,508	6,345	115,854	109,508	5,965	115,473
COUNCIL BLUFFS												
Earth	7,439	787	8,226	9,051	890	9,941	6,894	802	7,696	8,807	818	9,625
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
Concrete (Combined)	8,698	241	8,939	8,492	232	8,724	8,185	228	8,413	7,671	241	7,912
TOTAL	16,137	1,028	17,165	17,543	1,122	18,665	15,079	1,030	16,109	16,478	1,059	17,537
OTHERS												
Earth	2,352	503	2,855	3,231	886	4,117	2,109	435	2,544	3,920	506	4,426
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
Concrete (Combined)	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2,352	503	2,855	3,231	886	4,117	2,109	435	2,544	3,920	506	4,426

TABLE 35

STORMWATER
PRESENT WORTH COSTS FOR PAPILLION
(x $1,000)
1 Year Storm, Level 2

	Capital	O&M	Total
Concept A			
Papillion Earth	26,767	5,482	32,249
Papillion Concrete	116,550	3,168	119,718
Papillion Concrete (Combined)	62,561	2,275	64,836
Total	205,878	10,925	216,803
Concept B			
Papillion Earth	16,515	4,075	20,590
Papillion Concrete	98,892	3,287	102,179
Papillion Concrete (Combined)	65,621	2,275	67,896
Total	181,028	9,637	190,665
Concept C			
Papillion Earth	9,027	3,668	12,695
Papillion Concrete	91,459	6,037	97,496
Papillion Concrete (Combined)	52,587	2,062	54,649
Total	153,073	11,767	164,840
Concept D			
Papillion Earth	24,652	8,844	33,496
Papillion Concrete	94,342	3,693	98,035
Papillion Concrete (Combined)	55,848	2,133	57,981
Total	174,842	14,670	189,512

TABLE 36

SEWER COST COMPARISONS
CAPITAL COSTS
(x $1,000)

Papillion Full Extension	A	B	C	D
Cost with Combined Sewer Overflow	$17,091	$15,301	$15,151	$15,564
Cost of Sanitary Sewer Only	3,712	1,864	1,915	1,864
Δ Cost to Include Capacity for Combined Basins	$13,379	$13,437	$13,236	$13,700

Papillion Limited Extension	A	B	C	D
Cost with Combined Sewer Overflow	$11,851	$ 8,642	$11,381	$10,739
Cost of Sanitary Sewer Only	1,597	1,347	1,864	1,677
Δ Cost to Include Capacity for Combined Basins	$10,254	$ 7,295	$ 9,517	$ 9,062

Council Bluffs	A	B	C	D
Cost with Combined Sewer Overflow	$ 2,817	$ 2,032	$ 2,817	$ 2,113
Cost of Sanitary Sewer Only	0	0	0	0
Δ Cost to Include Capacity for Combined Basins	$ 2,817	$ 2,032	$ 2,817	$ 2,113

Wastewater Treatment

The wastewater treatment systems which remain constant throughout the plans largely involve the non-urban and minor urban treatment plants. This section provides the cost details for each of the individual plants while the data presented in the plan sections will only present the summaries. This was done to avoid the duplication of similar and lengthy tables.

Tables 37 and 38 illustrate the phased capital costs and annual operation and maintenance costs, respectively, for the non-urban plants. These tables show the costs for all levels of treatment, not including land treatment.

Tables 39 through 44 illustrate the phased capital costs and annual operation and maintenance costs for the minor urban plants. These tables show the costs associated with all levels of treatment in addition to the variations due to the growth concepts. Land treatment costs of Plan 3 are not shown here but are presented with the plan.

TABLE 37

NON-URBAN WASTEWATER TREATMENT PLANTS
CAPITAL EXPENDITURES ($1,000)

City	(LEVEL 1) 1977	(LEVEL 1) 1985	(LEVEL 1) 1995	(LEVEL 2) 1977	(LEVEL 2) 1985	(LEVEL 2) 1995	(LEVEL 3) 1977	(LEVEL 3) 1985	(LEVEL 3) 1995
WASHINGTON COUNTY, NEBRASKA									
Arlington	260	-	170	290	-	210	260	225	190
Herman	125	-	-	135	-	-	125	120	-
Kennard	135	-	-	145	-	-	135	120	-
CASS COUNTY, NEBRASKA									
Weeping Water	-	-	390	20	-	390	-	250	390
Union	110	-	-	120	-	-	110	105	-
Nehawka	60	-	110	70	-	110	60	-	250
Murray	140	-	-	150	-	-	140	120	-
Murdock	140	-	-	150	-	-	140	120	-
Manley	100	-	-	110	-	-	110	95	-
Louisville	-	-	390	20	-	390	-	250	390
Greenwood	240	-	45	255	-	50	240	190	70
Elmwood	220	-	40	240	-	30	220	180	60
Eagle	75	-	195	95	-	195	75	180	220
Avoca	-	-	125	10	-	125	-	100	130
Alvo	78	-	-	84	-	-	78	77	-
DOUGLAS COUNTY, NEBRASKA									
Waterloo	-	-	240	15	-	245	-	175	270
HARRISON COUNTY, IOWA									
Logan	390	-	-	410	-	-	390	170	-
Woodbine	390	-	-	410	-	-	390	170	-
Mondamin	150	-	-	160	-	-	150	130	-
Dunlap	350	-	-	380	-	-	350	250	-
Pisgah	130	-	-	140	-	-	130	120	-
POTTAWATTAMIE COUNTY, IOWA									
Avoca	330	-	-	350	-	-	330	230	-
Carson	85	-	170	100	-	170	85	200	170
Hancock	125	-	-	135	-	-	125	115	-
Macedonia	170	-	-	185	-	-	170	145	-
Minden	185	-	-	200	-	-	185	155	-
Neola	-	75	255	15	140	255	-	305	255
Oakland	375	-	35	400	-	45	375	265	70
Treynor	315	-	95	330	-	90	315	205	140
Underwood	230	-	45	250	-	45	230	185	70
Walnut	230	-	-	250	-	-	230	185	-
MILLS COUNTY, IOWA									
Emerson	190	-	10	200	-	10	190	150	30
Malvern	265	-	-	285	-	-	265	205	-
Tabor	270	-	30	290	-	30	270	250	-
TOTAL	5,863	75	2,345	6,399	140	2,390	5,873	5,742	2,705

TABLE 38

NON-URBAN WASTEWATER TREATMENT PLANTS
ANNUAL OPERATION & MAINTENANCE COSTS ($1,000/Yr.)

City	(LEVEL 1) 1975	1977	1985	1995	2020	(LEVEL 2) 1975	1977	1985	1995	2020	(LEVEL 3) 1975	1977	1985	1995	2020
WASHINGTON COUNTY, NEBRASKA															
Arlington	14	11	14	17	19	14	14	16	20	23	14	11	25	31	35
Herman	2	5	5	5	5	2	6	6	6	6	2	5	10	10	9
Kennard	2	5	6	6	6	2	6	6	7	6	2	5	10	10	10
CASS COUNTY, NEBRASKA															
Weeping Water	12	13	14	16	18	12	15	17	19	21	12	13	26	30	33
Union	2	4	4	4	4	2	5	5	5	5	2	4	8	8	8
Nehawka	5	4	5	6	7	5	5	6	7	9	5	4	10	11	13
Murray	2	5	5	5	6	2	5	6	6	7	2	5	9	10	11
Murdock	2	4	5	5	6	2	5	5	6	7	2	4	9	10	11
Manley	1	3	3	3	4	1	3	3	4	4	1	3	5	6	7
Louisville	11	11	11	11	10	11	13	13	13	12	11	11	20	19	19
Greenwood	3	7	9	11	15	3	9	11	13	18	3	7	17	21	28
Elmwood	3	8	9	10	13	3	9	10	12	15	3	8	16	19	23
Eagle	6	7	8	10	14	6	8	10	12	17	6	7	15	19	25
Avoca	4	4	4	5	5	4	5	5	5	6	4	4	8	9	10
Alvo	1	3	3	3	3	1	3	3	3	3	1	3	5	5	5
DOUGLAS COUNTY, NEBRASKA															
Waterloo	6	6	7	8	12	6	7	8	9	14	6	6	13	14	22
HARRISON COUNTY, IOWA															
Logan	9	17	19	21	23	9	20	22	25	27	9	17	34	38	42
Woodbine	8	15	17	20	23	8	18	24	24	27	8	15	31	37	42
Mondamin	3	6	6	6	5	3	7	7	7	6	3	6	12	12	10
Dunlap	8	15	16	18	19	8	17	19	21	23	8	15	30	33	36
Pisgah	2	5	5	5	6	2	5	5	6	6	2	5	9	10	10
POTTAWATTAMIE COUNTY, IOWA															
Avoca	9	17	18	18	18	9	21	21	21	22	9	17	33	33	34
Carson	11	10	11	12	13	11	11	13	14	15	11	10	20	23	24
Hancock	1	4	4	5	5	1	4	5	5	6	1	4	7	8	9
Macedonia	2	5	6	7	8	2	6	7	8	9	2	5	10	12	14
Minden	3	6	7	8	9	3	7	8	9	10	3	6	13	15	16
Neola	12	13	13	15	19	12	15	17	18	22	12	13	24	27	34
Oakland	10	18	20	21	25	10	21	23	25	30	10	18	36	38	46
Treynor	3	7	11	17	24	3	9	13	18	28	3	7	20	29	43
Underwood	3	6	8	11	14	3	8	10	13	17	3	6	16	20	26
Walnut	5	11	11	11	11	5	13	13	14	14	5	11	21	21	21
MILLS COUNTY, IOWA															
Emerson	3	7	8	9	10	3	8	9	10	11	3	7	14	16	18
Malvern	0	14	14	14	13	0	17	17	16	15	0	14	25	25	23
Tabor	6	12	13	14	16	6	14	15	16	19	6	12	23	25	29
TOTAL	174	288	319	357	408	174	339	375	417	480	174	288	584	654	746

TABLE 39

MINOR URBAN WASTEWATER TREATMENT PLANT CAPITAL EXPENDITURES ($1,000)

Level 1

Wastewater Treatment Plants	Plans in which Plant Exists	1977 Concepts A	1977 Concepts B	1977 Concepts C	1977 Concepts D	1995 Concepts A	1995 Concepts B	1995 Concepts C	1995 Concepts D
ADDITIONAL DRAINAGE AREAS									
Valley	1-2	210	580	210	210	640	670	640	640
Boystown	1-2	0	0	0	0	0	0	0	0
Springfield	1-2	460	2,110	460	460	540	640	540	540
Bellevue #1	1-2	0	0	0	0	0	0	0	0
Blair	1-2	1,600	2,650	1,600	1,600	100	450	100	100
Fort Calhoun	1-2	590	1,200	590	590	0	250	0	0
Plattsmouth	1-2	1,122	2,022	1,122	1,122	328	328	328	328
Missouri Valley	1-2	930	930	930	930	70	70	70	70
Glenwood	1-2	310	1,060	310	310	640	640	640	640
Deer Creek	1-2	0	750	0	0	0	210	0	0
East Bellevue	1-2	0	940	0	0	0	0	0	0
TOTAL		5,222	12,242	5,222	5,222	2,318	3,258	2,318	2,318
PAPILLION DRAINAGE AREA									
Gretna	1	0	588	0	0	0	0	0	0
Bennington	1	140	1,150	140	140	0	0	0	0
Elkhorn	1	240	1,170	240	240	0	0	0	0
TOTAL		380	2,908	380	380	0	0	0	0
PAPILLION DRAINAGE AREA									
Gretna	2	838	2,388	838	838	762	762	762	1,262
Bennington	2	310	1,770	310	310	390	630	390	390
Elkhorn	2	400	1,770	400	400	1,200	630	440	440
TOTAL		1,548	5,928	1,548	1,548	2,352	2,022	1,592	2,092

TABLE 40

MINOR URBAN
MINOR URBAN WASTEWATER TREATMENT PLANTS ANNUAL O&M ($1,000/yr.)

LEVEL I

Wastewater Treatment Plant	Plans in Which Plant Exists	1975 Concepts A	1975 B	1975 C	1975 D	1977 Concepts A	1977 B	1977 C	1977 D	1985 Concepts A	1985 B	1985 C	1985 D	1995 Concepts A	1995 B	1995 C	1995 D	2020 Concepts A	2020 B	2020 C	2020 D
Additional Drainage Areas																					
Valley	1-2	22	22	22	22	28	26	28	28	42	60	42	42	55	93	55	55	73	115	73	73
Boystown	1-2	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springfield	1-2	11	11	11	11	12	147	12	12	31	152	31	31	45	278	45	45	93	258	93	93
Bellevue #1	1-2	38	38	38	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blair	1-2	42	42	42	42	65	64	65	65	111	195	111	111	221	325	221	221	180	419	180	180
Fort Calhoun	1-2	25	25	25	25	48	42	48	48	41	76	41	41	33	106	33	33	43	145	43	43
Plattsmouth	1-2	26	26	26	26	61	59	61	61	96	196	96	96	135	291	135	135	146	301	146	146
Missouri Valley	1-2	22	22	22	22	39	37	39	39	59	100	59	59	80	169	80	80	91	174	91	91
Glenwood	1-2	55	55	55	55	49	45	49	49	65	104	65	65	83	169	83	83	77	174	77	77
Deer Creek	1-2	0	0	0	0	0	9	0	0	0	31	0	0	0	57	0	0	0	84	0	0
East Bellevue	1-2	0	0	0	0	0	12	0	0	0	40	0	0	0	80	0	0	0	84	0	0
Total		250	250	250	250	302	441	302	302	445	954	445	445	652	1,568	652	652	703	1,754	703	703
Papillion Drainage Area																					
Gretna	1	16	16	16	16	19	62	19	19	0	0	0	0	0	0	0	0	0	0	0	0
Bennington	1	9	9	9	9	9	6	9	9	0	0	0	0	0	0	0	0	0	0	0	0
Elkhorn	1	21	21	21	21	17	50	17	17	0	0	0	0	0	0	0	0	0	0	0	0
Total		46	46	46	46	45	118	45	45	0	0	0	0	0	0	0	0	0	0	0	0
Papillion Drainage Area																					
Gretna	2	16	16	16	16	20	28	20	20	63	183	63	63	102	330	102	102	161	476	161	261
Bennington	2	9	9	9	9	12	6	12	12	27	119	27	27	41	213	41	41	58	312	58	58
Elkhorn	2	21	21	21	21	23	133	23	23	34	496	34	34	44	213	44	44	157	312	71	71
Total		46	46	46	46	55	167	55	55	124	798	124	124	187	756	187	187	376	1,100	290	390

TABLE 41

MINOR URBAN WASTEWATER TREATMENT PLANTS CAPITAL EXPENDITURES ($1,000)

Level 2

Wastewater Treatment Plants	Plans in which Plant Exists	1977 Concepts A	1977 Concepts B	1977 Concepts C	1977 Concepts D	1995 Concepts A	1995 Concepts B	1995 Concepts C	1995 Concepts D
ADDITIONAL DRAIN-AGE ARES									
Valley	1-2	500	1,000	500	500	700	700	700	700
Boystown	1-2	0	0	0	0	0	0	0	0
Springfield	1-2	730	4,110	730	730	670	890	670	670
Bellevue #1	1-2	0	0	0	0	0	0	0	0
Blair	1-2	2,150	4,800	2,150	2,150	150	800	150	150
Fort Calhoun	1-2	840	2,000	840	840	0	350	0	0
Plattsmouth	1-2	1,672	4,022	1,672	1,672	328	328	328	328
Missouri Valley	1-2	1,300	1,300	1,300	1,300	100	100	100	100
Glenwood	1-2	660	1,610	660	660	640	640	640	640
Deer Creek	1-2	0	1,050	0	0	0	300	0	0
East Bellevue	1-2	0	1,300	0	0	0	0	0	0
TOTAL		7,852	21,192	7,852	7,852	2,588	4,108	2,588	2,588
PAPILLION DRAIN-AGE AREA									
Gretna	1	0	588	0	0	0	0	0	0
Bennington	1	140	1,150	140	140	0	0	0	0
Elkhorn	1	240	1,170	240	240	0	0	0	0
TOTAL		380	2,908	380	380	0	0	0	0
PAPILLION DRAIN-AGE AREA									
Gretna	2	1,288	4,588	1,288	1,288	862	1,412	862	3,512
Bennington	2	550	3,370	550	550	450	1,330	450	450
Elkhorn	2	670	3,370	670	670	1,430	1,330	480	480
TOTAL		2,508	11,328	2,508	2,508	2,742	4,072	1,792	4,442

TABLE 42

MINOR URBAN

MINOR URBAN WASTEWATER TREATMENT PLANTS ANNUAL O&M ($1,000/yr.)

LEVEL 2

Wastewater Treatment Plant	Plans in Which Plant Exists	1975 Concepts A	B	C	D	1977 Concepts A	B	C	D	1985 Concepts A	B	C	D	1995 Concepts A	B	C	D	2020 Concepts A	B	C	D
Additional Drainage Area																					
Valley	1-2	22	22	22	22	37	36	37	37	56	82	56	56	74	126	74	74	99	157	99	99
Boystown	1-2	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springfield	1-2	11	11	11	11	15	207	15	15	40	14	40	40	60	399	60	60	124	515	124	124
Bellevue #1	1-2	38	38	38	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blair	1-2	42	42	42	42	89	91	89	89	152	279	152	152	218	463	218	218	249	597	249	249
Fort Calhoun	1-2	25	25	25	25	62	57	62	62	54	103	54	54	43	146	43	43	56	201	56	56
Plattsmouth	1-2	26	26	26	26	84	86	84	84	133	244	1133	133	187	420	187	187	202	493	202	202
Missouri Valley	1-2	22	22	22	22	53	51	53	53	79	137	79	79	106	233	106	106	121	241	121	121
Glenwood	1-2	55	55	55	55	66	63	66	66	88	143	88	88	112	233	112	112	103	241	103	103
Deer Creek	1-2	0	0	0	0	0	13	0	0	0	42	0	0	0	78	0	0	0	115	0	0
East Bellevue	1-2	0	0	0	0	0	16	0	0	0	54	0	0	0	109	0	0	0	115	0	0
Total		250	250	250	250	406	620	406	406	602	1,298	602	602	800	2,207	800	800	954	2,615	954	954
Papillion Drainage Area																					
Gretna	1	16	16	16	16	19	62	19	19	0	0	0	0	0	0	0	0	0	0	0	0
Bennington	1	9	9	9	9	9	6	9	9	0	0	0	0	0	0	0	0	0	0	0	0
Elkhorn	1	21	21	21	21	17	50	17	17	0	0	0	0	0	0	0	0	0	0	0	0
Total		46	46	46	46	45	118	45	45	0	0	0	0	0	0	0	0	0	0	0	0
Papillion Drainage Area																					
Gretna	2	16	16	16	16	27	41	27	27	86	261	86	86	139	465	139	139	221	672	221	363
Bennington	2	9	9	9	9	16	8	16	16	35	269	35	35	55	304	55	55	77	443	77	77
Elkhorn	2	21	21	21	21	28	188	28	28	45	256	45	45	60	305	60	60	220	443	96	96
Total		46	46	46	46	71	237	71	71	166	686	166	166	254	1,074	254	254	518	1,558	394	536

TABLE 43

MINOR URBAN WASTEWATER TREATMENT PLANTS CAPITAL EXPENDITURES ($1,000)

Level 3

Wastewater Treatment Plants	Plans in which Plant Exists	1977 Concepts A	B	C	D	1985 Concepts A	B	C	D	1995 Concepts A	B	C	D
ADDITIONAL DRAINAGE AREAS													
Valley	1-2	210	580	210	210	740	1,070	740	740	750	800	750	750
Boystown	1-2	0	0	0	0	0	0	0	0	0	0	0	0
Springfield	1-2	460	2,110	460	460	650	3,330	650	650	890	1,000	890	890
Bellevue #1	1-2	0	0	0	0	0	0	0	0	0	0	0	0
Blair	1-2	1,600	2,650	1,600	1,600	1,550	3,650	1,550	1,550	200	1,000	200	200
Fort Calhoun	1-2	590	1,200	590	590	610	1,200	610	610	0	500	0	0
Plattsmouth	1-2	1,122	2,022	1,122	1,122	1,400	3,330	1,400	1,400	328	328	328	328
Missouri Valley	1-2	930	930	930	930	920	920	920	920	150	150	150	150
Glenwood	1-2	310	1,060	310	310	950	1,600	950	950	640	640	640	640
Deer Creek	1-2	0	750	0	0	0	750	0	0	0	400	0	0
East Bellevue	1-2	0	940	0	0	0	960	0	0	0	0	0	0
TOTAL		5,222	12,242	5,222	5,222	6,820	16,810	6,820	6,820	2,958	4,818	2,958	2,958
PAPILLION DRAINAGE AREA													
Gretna	1	0	588	0	0	0	0	0	0	0	0	0	0
Bennington	1	140	1,150	140	140	0	0	0	0	0	0	0	0
Elkhorn	1	240	1,170	240	240	0	0	0	0	0	0	0	0
TOTAL		380	2,908	380	380	0	0	0	0	0	0	0	0
PAPILLION DRAINAGE AREA													
Gretna	2	838	2,388	838	838	1,200	3,700	1,200	1,200	1,062	1,912	1,062	2,962
Bennington	2	310	1,770	310	310	590	2,700	590	590	500	1,330	500	500
Elkhorn	2	400	1,770	400	400	670	2,700	670	670	2,030	1,330	630	630
TOTAL		1,548	5,928	1,548	1,548	2,460	9,100	2,460	2,460	3,592	4,572	2,192	4,092

TABLE 44

MINOR URBAN

MINOR URBAN WASTEWATER TREATMENT PLANTS ANNUAL O&M ($1,000/yr.)

Level 3

Wastewater Treatment Plants	Plans in Which Plant Exists	1975 Concepts A	1975 B	1975 C	1975 D	1977 Concepts A	1977 B	1977 C	1977 D	1985 Concepts A	1985 B	1985 C	1985 D	1995 Concepts A	1995 B	1995 C	1995 D	2020 Concepts A	2020 B	2020 C	2020 D
Additional Drainage Areas																					
Valley	1-2	22	22	22	22	28	26	28	28	67	98	67	67	87	152	87	87	116	189	116	116
Boystown	1-2	9	9	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springfield	1-2	11	11	11	11	12	147	12	12	49	256	49	49	71	481	71	71	147	619	147	147
Bellevue #1	1-2	38	38	38	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blair	1-2	42	42	42	42	107	64	107	107	182	334	182	182	262	552	262	262	299	712	299	299
Fort Calhoun	1-2	25	25	25	25	48	42	48	48	64	124	64	64	51	175	51	51	67	240	67	67
Plattsmouth	1-2	26	26	26	26	61	59	61	61	159	291	159	159	223	501	223	223	241	517	241	241
Missouri Valley	1-2	22	22	22	22	39	37	39	39	95	165	95	95	128	280	128	128	145	289	145	145
Glenwood	1-2	55	55	55	55	49	45	49	49	105	173	105	105	134	280	134	134	123	289	123	123
Deer Creek	1-2	0	0	0	0	0	9	0	0	0	49	0	0	0	93	0	0	0	138	0	0
East Bellevue	1-2	0	0	0	0	0	12	0	0	0	65	0	0	0	130	0	0	0	138	0	0
Total		250	250	250	250	344	441	344	344	721	1,555	721	721	956	2,644	956	956	1,138	3,131	1,138	1,138
Papillion Drainage Area																					
Gretna	1	16	16	16	16	19	62	19	19	0	0	0	0	0	0	0	0	0	0	0	0
Bennington	1	9	9	9	9	9	6	9	9	0	0	0	0	0	0	0	C	0	0	0	0
Elkhorn	1	21	21	21	21	17	50	17	17	0	0	0	0	0	0	0	0	0	0	0	0
Total		46	46	46	46	45	118	45	45	0	0	0	0	0	0	0	0	0	0	0	0
Papillion Drainage Area																					
Gretna	2	16	16	16	16	20	28	20	20	104	314	104	104	167	558	167	167	266	806	266	431
Bennington	2	9	9	9	9	12	6	12	12	42	200	42	42	65	365	65	65	92	530	92	92
Elkhorn	2	21	21	21	21	23	133	23	23	54	303	54	54	72	366	72	72	264	530	115	115
Total		46	46	46	46	55	167	55	55	200	817	200	200	304	1,289	304	304	622	1,866	473	638

PLAN 1

Description

Plan 1 is patterned after the basic plan presented in the Phase I study; Plan I. The wastewater system follows the concept developed in the MAPA studies with regionalization of the basin wastewaters to three major plants: Council Bluffs (Mosquito Creek), Missouri River and Papillion. The Papillion sewer system is extended to include the communities of Bennington, Elkhorn and Gretna. The stormwater management system varies with basin. The combined overflows from the Omaha-Missouri River area (for a 1-year storm) are collected, stored and treated at the Missouri River Treatment Plant. In the Papillion and Council Bluffs basins, the one-year storm is treated and discharged at various upstream locations. A sub-option is presented for collection, storage and conveyance of combined sewer basins to the Papillion and Council Bluffs Treatment Plants. This includes two locations in the Papillion and one in the Council Bluffs area. Additional treatment units are required at the Papillion Plant but not at the Council Bluffs Plant. Generally, Level 1 stormwater treatment is required at all basins. However, if future Missouri River low flows are drastically reduced in the summer, Level 2 treatment may become necessary in the Papillion Basin.

Plate 5 presented at the end of this section illustrates Plan I.

Costs

The total wastewater plant costs for capital expenditure, annual O & M and present worth for Plan 1 are shown in Tables 45 through 47, respectively. These represent a composite of all wastewater costs for non-urban, minor urban and major urban plants. The components of the system have been kept separate to show the economic impact of wastewater treatment for each drainage area.

Table 48 presents the total present worth values for Plan 1. Appropriate sewer and stormwater components are added and a total for the plan is computed.

TABLE 45

WASTEWATER PLANTS
CAPITAL EXPENDITURES
(x $1,000)

PLAN I		1977 A	1977 B	1977 C	1977 D	1985 A	1985 B	1985 C	1985 D	1995 A	1995 B	1995 C	1995 D	Total A	Total B	Total C	Total D
(Level 1)	Papillion Drainage Area																
	Papillion	15,525	14,320	14,843	15,445					44,273	35,430	39,157	44,126				
	Minor Plants*	380	2,908	380	380					0	0	0	0				
	Total	15,905	17,228	15,223	15,825					44,273	35,430	39,157	44,126	60,178	52,658	54,380	59,951
	Missouri Drainage Area	26,907	26,907	29,152	26,907					10,000	10,000	10,000	10,000	36,907	36,907	39,152	36,907
	Council Bluffs Drainage Area	8,417	8,041	8,431	8,400					4,025	3,640	4,037	4,037	12,442	11,681	12,468	12,437
	Additional Drainage Areas																
	Minor Plants	5,222	12,242	5,222	5,222					2,318	3,258	2,318	2,318				
	Non-Urban Plants	5,863	5,863	5,863	5,863	75	75	75	75	2,345	2,345	2,345	2,345				
	Total	11,085	18,105	11,085	11,085	75	75	75	75	4,663	5,603	4,663	4,663	15,823	23,783	15,823	15,823
	Grand Total	62,314	70,281	63,891	62,217	75	75	75	75	62,961	54,673	57,857	62,826	125,350	125,029	121,823	125,118
(Level 2)	Papillion Drainage Area																
	Papillion	27,653	25,112	26,215	27,485					52,123	42,548	46,584	51,964				
	Minor Plants*	380	2,908	380	380					0	0	0	0				
	Total	28,033	28,020	26,595	27,865					52,123	42,548	46,584	51,964	80,156	70,568	73,179	79,829
	Missouri Drainage Area	37,531	37,531	40,663	37,531					10,000	10,000	10,000	10,000	47,531	47,531	50,663	47,531
	Council Bluffs Drainage Area	10,572	10,100	10,600	10,350					5,517	5,000	5,533	5,500	16,089	15,100	16,133	15,850
	Additional Drainage Areas																
	Minor Urban	7,852	21,192	7,852	7,852					2,588	4,108	2,588	2,588				
	Non-Urban Plants	6,399	6,399	6,399	6,399	140	140	140	140	2,390	2,390	2,390	2,390				
	Total	14,251	27,591	14,251	14,251	140	140	140	140	4,978	6,498	4,9788	4,978	19,369	34,229	19,369	19,369
	Grand Total	90,387	103,242	92,109	89,997	140	140	140	140	72,618	64,046	67,095	72,442	163,145	167,428	159,344	162,379
(Level 3)	Papillion Drainage Area																
	Papillion	15,525	14,320	14,843	15,445	20,948	18,141	19,360	20,763	58,080	47,693	52,227	57,912				
	Minor Plants*	380	2,908	380	380	0	0	0	0	0	0	0	0				
	Total	15,905	17,228	15,223	15,825	20,948	18,141	19,360	20,763	58,080	47,693	52,227	57,912	94,933	83,062	86,810	94,500
	Missouri Drainage Area	26,907	26,907	29,152	26,907	19,368	19,368	20,984	19,368	10,000	10,000	10,000	10,000	56,275	56,275	60,136	56,275
	Council Bluffs Drainage Area	8,417	8,041	8,431	8,400	5,267	4,866	5,291	5,078	7,869	7,114	7,893	7,917	21,553	20,021	21,615	21,395
	Additional Drainage Areas																
	Minor Urban	5,222	12,242	5,222	5,222	6,820	16,810	6,820	6,820	2,958	4,818	2,958	2,958				
	Non-Urban	5,873	5,873	5,873	5,873	5,742	5,742	5,742	5,742	2,705	2,705	2,705	2,705				
	Total	11,095	18,115	11,095	11,095	12,562	22,552	12,562	12,562	5,663	7,523	5,663	5,663	29,320	48,190	29,320	29,320
	Grand Total	62,324	70,291	63,901	62,227	58,145	64,927	58,197	57,771	81,612	72,330	75,783	81,492	202,081	207,548	197,881	201,490

*These Plants are Elkhorn, Gretna, and Bennington.

TABLE 46

WASTEWATER PLANTS
O & M
(x $1,000/yr)

PLAN 1		1975 A	1975 B	1975 C	1975 D	1977 A	1977 B	1977 C	1977 D	1985 A	1985 B	1985 C	1985 D	1995 A	1995 B	1995 C	1995 D	2020 A	2020 B	2020 C	2020 D
(Level 1)	Papillion Drainage Area																				
	Papillion STP	829	829	829	829	1,348	1,279	1,348	1,348	2,059	1,916	1,958	2,045	3,620	3,186	3,371	3,601	4,668	4,109	4,345	4,659
	Minor Urban*	46	46	46	46	45	118	45	45	0	0	0	0	0	0	0	0	0	0	0	0
	Total	875	875	875	875	1,393	1,397	1,393	1,393	2,059	1,916	1,958	2,045	3,620	3,186	3,371	3,601	4,668	4,109	4,345	4,659
	Missouri Drainage Area	1,222	1,222	1,222	1,222	1,968	1,947	1,989	1,973	2,052	1,999	2,104	2,067	2,466	2,267	2,692	2,534	3,164	3,159	3,542	3,164
	Council Bluffs Drainage Area	353	353	353	353	541	529	541	541	729	682	735	735	1,281	1,146	1,287	1,287	1,757	1,569	1,763	1,763
	Additional Drainage Areas																				
	Minor Urban	250	250	250	250	302	441	302	302	445	954	445	445	652	1,568	652	652	703	1,754	703	703
	Non Urban	174	174	174	174	288	288	288	288	319	319	319	319	357	357	357	357	408	408	408	408
	Total	424	424	424	424	590	729	590	590	764	1,273	764	764	1,009	1,925	1,009	1,009	1,111	2,162	1,111	1,111
	Grand Total	2,874	2,874	2,874	2,874	4,492	4,602	4,513	4,497	5,604	5,870	5,561	5,611	8,376	8,524	8,359	8,431	10,700	10,999	10,761	10,697
(Level 2)	Papillion Drainage Area																				
	Papillion STP	829	829	829	829	2,206	2,093	2,206	2,206	3,536	3,136	3,204	3,347	6,178	5,213	5,516	5,893	8,033	6,724	7,110	7,623
	Minor Urban*	46	46	46	46	45	118	45	45	0	0	0	0	0	0	0	0	0	0	0	0
	Total	875	875	875	875	2,251	2,211	2,251	2,251	3,536	3,136	3,204	3,347	6,178	5,213	5,516	5,893	8,033	6,724	7,110	7,623
	Missouri Drainage Area	1,222	1,222	1,222	1,222	3,069	3,037	3,102	3,078	3,200	3,119	3,282	3,225	3,847	3,536	4,199	3,953	4,936	4,927	5,525	4,936
	Council Bluffs Drainage Area	353	353	353	353	811	793	811	811	1,093	1,023	1,102	1,102	1,922	1,719	1,930	1,930	2,636	2,354	2,644	2,644
	Additional Drainage Areas																				
	Minor Urban	250	250	250	250	406	620	406	406	602	1,298	602	602	800	2,207	800	800	954	2,615	954	954
	Non Urban	174	174	174	174	339	339	339	339	375	375	375	375	417	417	417	417	480	480	480	480
	Total	424	424	424	424	745	959	745	745	977	1,673	977	977	1,217	2,624	1,217	1,217	1,434	3,095	1,434	1,434
	Grand Total	2,874	2,874	2,874	2,874	6,876	7,000	6,909	6,885	8,806	8,951	8,565	8,651	13,164	13,092	12,862	12,993	17,039	17,100	16,713	16,637
(Level 3)	Papillion Drainage Area																				
	Papillion STP	829	829	829	829	1,348	1,279	1,348	1,348	3,923	3,651	3,730	3,897	5,559	4,891	5,181	5,515	8,893	7,824	8,278	8,878
	Minor Urban*	46	46	46	46	45	118	45	45	0	0	0	0	0	0	0	0	0	0	0	0
	Total	875	875	875	875	1,393	1,397	6,393	1,393	3,923	3,651	3,730	3,897	5,559	4,891	5,181	5,515	8,893	7,824	8,278	8,878
	Missouri Drainage Area	1,222	1,222	1,222	1,222	1,968	1,947	1,989	1,973	3,668	3,501	3,862	3,730	4,134	3,800	4,513	4,249	5,304	5,295	5,946	5,304
	Council Bluffs Drainage Area	353	353	353	353	541	529	541	541	1,886	1,376	1,287	1,332	1,620	1,610	1,443	1,532	2,946	2,937	2,622	2,555
	Additional Drainage Areas																				
	Minor Urban	250	250	250	250	344	441	344	344	721	1,555	721	721	956	2,644	956	956	1,138	3,131	1,138	1,138
	Non Urban	174	174	174	174	288	288	288	288	584	584	584	584	654	654	654	654	746	746	746	746
	Total	424	424	424	424	632	729	632	632	1,305	2,139	1,305	1,305	1,610	3,298	1,610	1,610	1,884	3,877	1,884	1,884
	Grand Total	2,874	2,874	2,874	2,874	4,492	4,602	4,555	4,497	10,782	10,667	10,184	10,264	12,923	13,599	12,747	12,906	19,027	19,933	18,730	19,015

*These Plants are Elkhorn, Gretna, and Bennington.

TABLE 47

WASTEWATER PRESENT WORTH
(x $1,000,000)

PLAN 1

	CAPITAL				O & M				TOTAL			
	A	B	C	D	A	B	C	D	A	B	C	D
(LEVEL 1)												
Papillion Drainage Area	33.4	32.9	30.9	33.2	35.8	38.3	33.9	35.6	69.2	71.2	64.8	68.8
Missouri Drainage Area	35.7	35.7	38.4	29.5	29.6	28.7	31.2	28.1	65.3	64.4	69.6	57.6
Council Bluffs Drainage Area	11.5	10.9	11.5	11.4	12.2	11.2	12.3	12.3	23.7	22.1	23.8	23.7
Additional Drainage Areas	16.8	26.5	16.8	16.8	12.2	21.5	12.2	12.2	29.0	48.0	29.0	29.0
TOTAL	97.4	106.0	97.6	90.9	89.8	99.7	89.6	88.2	187.2	205.7	187.2	179.1
(LEVEL 2)												
Papillion Drainage Area	50.5	48.2	47.0	50.3	56.9	57.8	53.9	56.7	107.4	106.0	100.9	107.0
Missouri Drainage Area	48.5	48.5	63.2	48.5	44.9	43.5	47.4	45.4	93.4	92.0	110.6	93.9
Council Bluffs Drainage Area	14.5	13.8	14.6	14.3	18.0	16.5	18.1	18.1	32.5	30.3	32.7	32.4
Additional Drainage Areas	20.9	38.6	20.9	20.9	15.7	28.6	15.7	15.7	36.6	67.2	36.6	36.6
TOTAL	134.4	149.1	145.7	134.0	135.5	146.4	135.1	135.9	269.9	295.5	280.8	269.9
(LEVEL 3)												
Papillion Drainage Area	59.9	64.0	56.1	59.6	59.9	60.6	56.6	59.5	119.8	124.6	112.7	119.1
Missouri Drainage Area	54.6	54.6	58.9	54.6	52.4	50.2	56.0	53.1	107.0	104.8	114.9	107.7
Council Bluffs Drainage Area	17.4	16.5	17.5	17.3	18.6	17.1	18.7	18.1	36.0	33.6	36.2	35.4
Additional Drainage Area	27.9	46.7	27.9	27.9	17.6	29.9	17.6	17.6	45.5	76.6	45.5	45.5
TOTAL	159.8	181.8	160.4	159.4	148.5	157.8	148.9	148.3	308.3	339.6	309.3	307.7

TABLE 48

PLAN 1

TOTAL PRESENT WORTH SUMMARY
(x $1,000,000)

	Level 1				Level 2				Level 3			
	Concepts				Concepts				Concepts			
	A	B	C	D	A	B	C	D	A	B	C	D
PAPILLION												
Wastewater, Major Urban	69.1	71.0	64.7	68.7	107.3	105.9	100.8	106.9	119.7	124.4	112.6	119.0
Wastewater, Minor Urban	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1
Stormwater, Not Combined-Upsystem	92.7	94.3	90.5	97.5	92.7	94.3	90.5	97.5	119.7	122.8	110.2	131.5
Stormwater, Combined-Upsystem	51.6	54.3	43.7	41.7	51.6	54.3	43.7	41.7	64.8	67.9	54.6	58.0
Stormwater, Combined-Conveyance	76.3	74.3	64.6	62.2	76.3	74.3	64.6	62.2	79.5	77.5	66.8	64.6
Interceptor, Total	10.3	8.4	7.8	8.4	10.3	8.4	7.8	8.4	10.3	8.4	7.8	8.4
Interceptor, Just Combined (Δ)	9.8	9.8	9.7	10.0	10.6	9.8	9.7	10.0	10.6	9.8	9.7	10.0
MISSOURI RIVER												
Wastewater	65.3	64.4	69.6	57.6	93.4	92.0	110.6	93.9	107.0	104.8	114.9	107.7
Stormwater, Combined-Upsystem	196.1	195.8	189.4	199.3	196.1	195.8	189.4	199.3	259.7	248.6	249.5	246.8
Stormwater, Combined-Tunnel	129.0	129.2	129.7	129.9	129.0	129.2	129.7	129.9	132.5	132.8	133.7	133.1
Interceptor, Total	(	Use Existing		)	(	Use Existing		)	(	Use Existing		)
COUNCIL BLUFFS												
Wastewater	23.7	22.1	23.8	23.7	32.5	30.3	32.7	32.4	36.0	33.6	36.2	35.4
Stormwater, Not Combined-Upsystem	8.2	9.9	7.7	9.6	8.2	9.9	7.7	9.6	11.2	13.0	11.1	14.9
Stormwater, Combined-Upsystem	8.9	8.7	8.4	7.9	8.9	8.7	8.4	7.9	9.9	9.7	9.3	8.8
Stormwater, Combined-Conveyance	11.3	11.5	10.8	10.5	11.3	11.5	10.8	10.5	11.5	11.8	11.1	10.8
Interceptor, Total	(	Use Existing	)	0.1	(	Use Existing	)	0.1	(	Use Existing	)	0.1
Interceptor, Just Combined (Δ)	2.0	1.4	2.0	1.3	2.0	1.4	2.0	1.3	2.0	1.4	2.0	1.3
ADDITIONAL AREAS												
Wastewater	29.0	48.0	29.0	29.0	36.6	67.2	36.6	36.6	45.5	76.6	45.5	45.5
Stormwater, Not Combined-Upsystem	2.9	4.1	2.5	4.4	2.9	4.1	2.5	4.4	3.8	5.6	3.9	4.0
STORMWATER LAND AND SLUDGE HANDLING CAPITAL												
Papillion, Not Combined-Upsystem	3.7	2.9	3.2	4.0	3.7	2.9	3.2	4.0	4.1	3.3	3.5	4.5
Papillion, Combined-Upsystem	0.8	0.8	0.7	0.5	0.8	0.8	0.7	0.5	1.0	1.0	0.8	0.6
Remaining, Not Combined-Upsystem	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4
Remaining, Combined-Upsystem	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.2
Missouri River, Combined-Upsystem	2.8	2.7	2.8	2.9	2.8	2.7	2.8	2.9	3.3	3.2	3.4	3.5

PLAN 2

Description

Plan 2 generally follows current wastewater management planning by regionalizing to three major urban plants except that the extent of the Papillion service district is reduced from Plan 1. The outer basin communities of Bennington, Elkhorn and Gretna are not incorporated into the Papillion sewer district but remain as independent sub-districts.

The stormwater management is identical with that of Plan 1, with Level 1 treatment of the one-year storm at upstream locations with discharges to the streams. The Missouri River combined overflows are stored and treated at a single location. Additional treatment and the possibility of conveyance of Papillion and Council Bluffs combined sewer overflows to treatment at municipal treatment plants are considered.

Plate 6 presented at the end of this section illustrates Plan 2.

Costs

Plan 2 is presented in the same format as Plan 1 to aid in the comparisons. The total wastewater plant costs for capital expenditures, annual O & M, and present worth for Plan 2 are shown in Tables 49 through 51, respectively. Table 52 shows the total present worth costs for Plan 2 including the appropriate sewer and stormwater components.

TABLE 49

WASTEWATER PLANTS
CAPITAL EXPENDITURES
(x $1,000)

PLAN 2		1977 A	1977 B	1977 C	1977 D	1985 A	1985 B	1985 C	1985 D	1995 A	1995 B	1995 C	1995 D	Total A	Total B	Total C	Total D
(Level 1)	**Papillion Drainage Area**																
	Papillion	15,003	12,530	14,336	14,986					41,203	23,225	36,087	41,130				
	Minor Plants*	1,548	5,928	1,548	1,548					2,352	2,022	1,592	2,092				
	Total	16,551	18,458	15,884	16,534					43,555	25,247	37,679	43,222	60,106	43,705	53,563	59,756
	Missouri Drainage Area	26,907	26,907	29,152	26,907					10,000	10,000	10,000	10,000	36,907	36,907	39,152	36,907
	Council Bluffs Drainage Area	8,417	8,041	8,431	8,400					4,025	3,640	4,037	4,037	12,442	11,681	12,468	12,437
	Additional Drainage Areas																
	Minor-Urban	5,222	12,242	5,222	5,222					2,318	3,258	2,318	2,318				
	Non Urban	5,863	5,863	5,863	5,863	75	75	75	75	2,345	2,345	2,345	2,345				
	Total	11,085	13,105	11,085	11,085	75	75	75	75	4,663	5,603	4,663	4,663	15,823	23,783	15,823	15,823
	Grand Total	62,960	71,511	64,552	62,926	75	75	75	75	62,243	44,490	56,379	61,922	125,278	116,076	121,006	124,923
(Level 2)	**Papillion Drainage Area**																
	Papillion	26,616	21,336	25,146	26,156					48,799	29,334	43,260	48,720				
	Minor Plants*	2,508	11,328	2,508	2,508					4,742	4,072	1,792	4,442				
	Total	29,124	32,664	27,654	28,664					53,541	33,406	45,052	53,162	82,665	66,070	72,706	81,826
	Missouri Drainage Area	37,531	37,531	40,663	37,531					10,000	10,000	10,000	10,000	47,531	47,531	50,663	47,531
	Council Bluffs Drainage Area	10,572	10,100	10,600	10,350					5,517	5,000	5,533	5,500	16,089	15,100	16,133	15,850
	Additional Drainage Areas																
	Minor-Urban	7,852	21,192	7,852	7,852					2,588	4,108	2,588	2,588				
	Non Urban	6,399	6,399	6,399	6,399	140	140	140	140	2,390	2,390	2,390	2,390				
	Total	14,251	27,591	14,251	14,251	140	140	140	140	4,978	6,498	4,978	4,978	19,369	34,229	19,369	19,369
	Grand Total	91,478	107,886	93,168	90,796	140	140	140	140	74,036	54,904	65,563	73,640	165,654	162,930	158,871	164,576
(Level 3)	Papillion Drainage Area																
	Papillion	15,033	12,530	14,336	14,986	19,803	13,969	18,178	19,692	54,568	34,002	48,716	54,485				
	Minor Plants*	1,548	5,928	1,548	1,548	2,460	9,100	2,460	2,460	3,592	4,572	2,192	4,092				
	Total	16,581	18,458	15,884	16,534	22,263	23,069	20,633	22,152	58,160	38,574	50,908	58,577	97,004	80,101	87,430	97,263
	Missouri Drainage Area	26,907	26,907	29,152	26,907	19,368	19,368	20,984	19,368	10,000	10,000	10,000	10,000	56,275	56,275	60,136	56,275
	Council Bluffs Drainage Area	8,417	8,041	8,431	8,400	5,267	4,866	5,291	5,078	7,869	7,114	7,893	7,917	21,553	20,021	21,615	21,395
	Additional Drainage Areas																
	Minor-Urban	5,222	12,242	5,222	5,222	6,820	16,810	6,820	6,820	2,958	4,818	2,958	2,958				
	Non Urban	5,873	5,873	5,873	5,873	5,742	5,742	5,742	5,742	2,705	2,705	2,705	2,705				
	Total	11,095	18,115	11,095	11,095	12,562	22,552	12,562	12,562	5,663	7,523	5,663	5,663	29,320	48,190	29,320	29,320
	Grand Total	63,000	71,521	64,562	62,936	59,460	69,855	59,475	59,160	81,692	63,211	74,464	82,157	204,152	204,587	198,501	204,253

*These Plants are Elkhorn, Gretna, and Bennington.

TABLE 50

WASTEWATER PLANTS
O & M
(x $1,000/yr)

PLAN 2		1975				1977				1985				1995				2020			
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
(Level 1)	Papillion Drainage Area																				
	Papillion STP	829	829	829	829	1,307	1,237	1,288	1,307	1,958	1,543	1,861	1,948	3,454	2,563	3,204	3,444	4,474	3,338	4,151	4,469
	Minor Urban*	46	46	46	46	55	167	55	55	124	798	124	124	187	756	187	187	376	1,100	290	390
	Total	875	875	875	875	1,362	1,404	1,343	1,362	2,082	2,341	1,985	2,072	3,641	3,319	3,391	3,631	4,850	4,438	4,441	4,959
	Missouri Drainage Area	1,222	1,222	1,222	1,222	1,968	1,947	1,989	1,973	2,052	1,999	2,104	2,067	2,466	2,267	2,692	2,534	3,164	3,159	3,542	3,164
	Council Bluffs Drainage Area	353	353	353	353	541	529	541	541	729	682	735	735	1,281	1,146	1,287	1,287	1,757	1,569	1,763	1,763
	Additional Drainage Areas																				
	Minor Urban	250	250	250	250	302	441	302	302	445	954	445	445	652	1,568	652	652	703	1,754	703	703
	Non Urban	174	174	174	174	288	288	288	288	319	319	319	319	357	357	357	357	408	408	408	408
	Total	424	424	424	424	590	729	590	590	764	1,273	764	764	1,009	1,925	1,009	1,009	1,111	2,162	1,111	1,111
Grand Total		2,874	2,874	2,874	2,874	4,461	4,609	4,463	4,466	5,627	6,295	6,588	5,638	8,397	8,657	8,379	8,461	10,882	11,328	10,857	10,897
(Level 2)	Papillion Drainage Area																				
	Papillion STP	829	829	829	829	2,138	2,025	2,108	2,138	3,204	2,607	3,045	3,188	5,652	7,330	5,244	5,636	7,321	5,463	6,792	7,314
	Minor Urban*	46	46	46	46	71	237	71	71	166	686	166	166	254	1,074	254	254	518	1,558	394	536
	Total	875	875	875	875	2,209	2,262	2,209	2,209	3,370	3,293	3,211	3,354	5,906	8,404	5,498	5,890	7,839	7,021	7,186	7,850
	Missouri Drainage Area	1,222	1,222	1,222	1,222	3,069	3,037	3,102	3,078	3,200	3,119	3,282	3,225	3,847	3,536	4,199	3,953	4,936	4,927	5,525	4,936
	Council Bluffs Drainage Area	353	353	353	353	811	793	811	811	1,093	1,023	1,102	1,102	1,922	1,719	1,930	1,930	2,636	2,354	2,644	2,644
	Additional Drainage Areas																				
	Minor Urban	250	250	250	250	406	620	406	406	602	1,298	602	602	800	2,207	800	800	954	2,615	954	954
	Non Urban	174	174	174	174	339	339	339	339	375	375	375	375	417	417	417	417	480	480	480	480
	Total	424	424	424	424	745	959	745	745	977	1,673	977	977	1,217	2,624	1,217	1,217	1,434	3,095	1,434	1,434
Grand Total		2,874	2,874	2,874	2,874	6,834	7,051	6,837	6,843	8,640	9,108	8,572	8,658	12,892	16,283	12,844	12,990	16,845	17,397	16,789	16,864
(Level 3)	Papillion Drainage Area																				
	Papillion STP	829	829	829	829	1,307	1,237	1,288	1,307	3,002	3,035	3,545	3,712	5,287	3,897	4,900	5,260	8,524	6,360	7,908	8,515
	Minor Urban*	64	64	64	64	55	167	55	55	200	817	200	200	304	1,289	304	304	622	1,866	473	638
	Total	875	875	875	875	1,362	1,404	1,343	1,362	3,202	3,852	3,745	3,912	5,591	5,186	5,204	5,564	9,146	8,226	8,381	9,153
	Missouri Drainage Area	1,222	1,222	1,222	1,222	1,968	1,947	1,989	1,973	3,668	3,501	3,862	3,730	4,134	3,800	4,513	4,249	5,304	5,295	5,946	5,304
	Council Bluffs Drainage Area	353	353	353	353	541	529	541	541	1,886	1,376	1,287	1,332	1,620	1,610	1,443	1,532	2,946	2,937	2,622	2,955
	Additional Drainage Areas																				
	Minor Urban	250	250	250	250	344	441	344	344	721	1,555	721	721	956	2,644	956	956	1,138	3,131	1,138	1,138
	Non Urban	174	174	174	174	288	288	288	288	584	584	584	584	654	654	654	654	746	746	746	746
	Total	424	424	424	424	632	729	632	632	1,305	2,139	1,305	1,305	1,610	3,298	1,610	1,610	1,884	3,877	1,884	1,884
Grand Total		2,874	2,874	2,874	2,874	4,503	4,609	4,505	4,508	10,061	10,868	10,199	10,279	12,955	13,894	12,770	12,955	19,280	20,335	18,833	19,296

*These Plants are Elkhorn, Gretna, and Bennington.

TABLE 51

WASTEWATER PRESENT WORTH
(x $1,000,000)

PLAN 2

	CAPITAL				O & M				TOTAL			
(LEVEL 1)	A	B	C	D	A	B	C	D	A	B	C	D
Papillion Drainage Area	34.9	24.1	31.2	40.8	32.3	25.5	30.4	32.2	67.2	49.6	61.6	73.0
Missouri Drainage Area	35.7	35.7	38.4	29.5	29.6	28.7	31.2	28.1	65.3	64.4	69.6	57.6
Council Bluffs Drainage Area	11.5	10.9	11.5	11.4	12.2	11.2	12.3	12.3	23.7	22.1	23.8	23.7
Additional Drainage Areas	16.8	26.5	16.8	16.8	12.2	21.5	12.2	12.2	29.0	48.0	29.0	29.0
TOTAL	98.9	97.2	97.9	98.5	86.3	86.9	86.1	84.8	185.2	184.1	184.0	183.3
(LEVEL 2)												
Papillion Drainage Area	51.9	41.5	48.0	54.9	54.0	40.8	48.7	51.6	105.9	82.3	96.7	106.5
Missouri Drainage Area	48.5	48.5	63.2	48.5	44.9	43.5	47.7	45.4	93.4	92.0	110.6	93.9
Council Bluffs Drainage Area	14.5	13.8	14.6	14.3	18.0	16.5	18.1	18.1	32.5	30.3	32.7	32.4
Additional Drainage Areas	20.9	38.6	20.9	20.9	15.7	28.6	15.7	15.7	36.6	67.2	36.6	36.6
TOTAL	135.8	142.4	146.7	138.6	132.6	129.4	129.9	130.8	268.4	271.8	276.6	269.4
(LEVEL 3)												
Papillion Drainage Area	54.9	31.9	49.3	56.1	54.3	42.4	51.0	54.1	109.2	74.3	100.3	111.2
Missouri Drainage Area	54.6	54.6	58.9	54.6	52.4	50.2	56.0	53.1	107.0	104.8	114.9	107.7
Council Bluffs Drainage Area	17.4	16.5	17.5	17.3	18.6	17.1	18.7	18.1	36.0	33.6	36.2	35.4
Additional Drainage Areas	27.9	46.7	27.9	27.9	17.6	29.9	17.6	17.6	45.5	76.6	45.5	45.5
TOTAL	154.8	149.7	153.6	155.9	142.9	139.6	143.3	142.9	297.7	289.3	296.9	298.8

TABLE 52

PLAN 2

TOTAL PRESENT WORTH SUMMARY
(x $1,000,000)

	Level 1				Level 2				Level 3			
	Concepts				Concepts				Concepts			
	A	B	C	D	A	B	C	D	A	B	C	D
PAPILLION												
Wastewater, Major Urban	62.7	33.4	57.1	68.5	99.4	55.6	90.2	100.0	101.9	48.7	93.0	103.9
Wastewater, Minor Urban	4.5	16.2	4.5	4.5	6.5	26.7	6.5	6.5	7.3	27.6	7.3	7.3
Stormwater, Not Combined - Upsystem	92.7	94.3	90.5	97.5	92.7	94.3	90.5	97.5	119.7	122.8	110.2	131.5
Stormwater, Combined - Upsystem	51.6	54.3	43.7	41.7	51.6	54.3	43.7	41.7	64.8	67.9	54.6	58.0
Stormwater, Combined - Conveyance	76.3	74.3	64.6	62.2	76.3	74.3	64.6	62.2	79.5	77.5	66.8	64.6
Interceptor, Total	8.3	5.8	4.8	7.2	8.3	5.8	4.8	7.2	8.3	5.8	4.8	7.2
Interceptor, Just Combined (Δ)	7.5	5.3	7.1	6.7	7.5	5.3	7.1	6.7	7.5	5.3	7.1	6.7
MISSOURI RIVER												
Wastewater	65.3	64.4	69.6	57.6	93.4	92.0	110.6	93.9	107.0	104.8	114.9	107.7
Stormwater, Combined - Upsystem	196.1	195.8	189.4	199.3	196.1	195.8	189.4	199.3	259.7	248.6	249.5	246.8
Stormwater, Combined - Tunnel	129.0	129.2	129.7	129.9	129.0	129.2	129.7	129.9	132.5	132.8	133.7	133.1
Interceptor, Total	(Use Existing)				(Use Existing)				(Use Existing)			
COUNCIL BLUFFS												
Wastewater	23.7	22.1	23.8	23.7	32.5	30.3	32.7	32.4	36.0	33.6	36.2	35.4
Stormwater, Not Combined - Upsystem	8.2	9.9	7.7	9.6	8.2	9.9	7.7	9.6	11.2	13.0	11.1	14.9
Stormwater, Combined - Upsystem	8.9	8.7	8.4	7.9	8.9	8.7	8.4	7.9	9.9	9.7	9.3	8.8
Stormwater, Combined - Conveyance	11.3	11.5	10.8	10.5	11.3	11.5	10.8	10.5	11.5	11.8	11.1	10.8
Interceptor, Total	(Use Existing)			0.1	(Use Existing)			0.1	(Use Existing)			0.1
Interceptor, Just Combined (Δ)	2.0	1.4	2.0	1.3	2.0	1.4	2.0	1.3	2.0	1.4	2.0	1.3
ADDITIONAL AREAS												
Wastewater	29.0	48.0	29.0	29.0	36.6	67.2	36.6	36.6	45.5	76.6	45.5	45.5
Stormwater, Not Combined - Upsystem	2.9	4.1	2.5	4.4	2.9	4.1	2.5	4.4	3.8	5.6	3.9	4.0
STORMWATER LAND AND SLUDGE HANDLING CAPITAL												
Papillion, Not Combined - Upsystem	3.7	2.9	3.2	4.0	3.7	2.9	3.2	4.0	4.1	3.3	3.5	4.5
Papillion, Combined - Upsystem	0.8	0.8	0.7	0.5	0.8	0.8	0.7	0.5	1.0	1.0	0.8	0.6
Remaining, Not Combined - Upsystem	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4
Remaining, Combined - Upsystem	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.2
Missouri River, Combined - Upsystem	2.8	2.7	2.8	2.9	2.8	2.7	2.8	2.9	3.3	3.2	3.4	3.5

PLAN 3

Description

Plan 3 envisions smaller land treatment systems developing within the seven county area. The non-urban and minor urban plants will provide secondary treatment, with effluent applied to local land treatment facilities. The three major urban plants are designed to treat by conventional methods to the required treatment levels before discharge to the Missouri River. The stormwater system and sewer system layout are identical to Plan 2. The components consist of non-urban costs that do not vary with growth concept, minor urban systems that do vary with growth concept, and the major urban plants which also vary.

Plates 7 and 8 presented at the end of this section illustrate Plan 3.

Costs

Table 53 shows the land treatment capital costs for the non-urban plants. The costs represent the total cost of the system for facilities and land required for 1995 and 2020 flows. Storage costs represent the 2020 requirements.

Table 54 is patterned after Table 53 for the minor urban plants. The total non-urban total costs are also shown and a total for the land treatment is presented.

Table 55 shows the summary present worth values for Plan 3. In developing the present worth, a set of assumptions is used in the phased construction to make the costs more reflective of practice. The assumptions are as follows:

TABLE 53

LAND TREATMENT CAPITAL COSTS
NON-URBAN PLANTS

Non-Urban Wastewater Treatment Plants	Storage Cost		Irrigation Cost 1995		Irrigation Cost 2020		Total Cost 2020
	Facilities	Land	Facilities*	Land	Facilities*	Land	
Arlington	$ 106,560	$ 3,240	$ 67,702	$ 33,899	$ 76,950	$ 38,529	$ 225,279
Herman	36,190	630	15,440	7,731	14,932	7,476	59,228
Kennard	38,885	690	16,968	8,496	16,374	8,199	64,148
Weeping Water	106,560	3,240	69,229	34,664	76,950	38,529	225,279
Union	30,193	510	12,132	6,075	11,623	5,820	48,146
Nehawka	50,616	990	19,344	9,685	23,755	11,894	87,255
Murray	40,668	720	16,374	8,199	17,477	8,751	67,616
Murdock	40,668	720	15,950	7,986	17,477	8,751	67,616
Manley	27,313	450	9,162	4,588	10,180	5,098	43,041
Louisville	75,361	1,800	45,050	22,557	43,099	21,580	141,840
Greenwood	91,516	2,490	43,608	21,835	58,540	29,311	181,857
Elmwood	81,088	2,040	38,263	19,158	47,850	23,959	154,937
Eagle	85,477	2,220	39,196	19,626	52,261	26,168	166,126
Avoca	36,190	630	13,574	6,797	14,932	7,476	59,228
Alvo	19,908	270	6,787	3,398	6,787	3,398	30,363
Logan	121,900	4,140	99,517	49,829	109,274	54,714	290,028
Woodbine	121,900	4,140	85,688	42,905	109,274	54,714	290,028
Mondamin	39,909	720	19,853	9,940	16,968	8,496	66,093
Dunlap	109,792	3,450	74,490	37,297	80,259	40,186	233,687
Pisgah	38,885	690	15,441	7,731	16,374	8,199	64,148
Avoca	104,643	3,120	73,047	36,575	73,980	37,043	218,786
Carson	81,540	2,040	45,474	22,769	48,359	24,213	156,152
Hancock	36,190	630	13,574	6,797	14,932	7,476	59,228

TABLE 53 - (CONT.)

LAND TREATMENT CAPITAL COSTS

Non-Urban Wastewater Treatment Plants	Storage Cost		Irrigation Cost				Total Cost 2020
			1995		2020		
	Facilities	Land	Facilities*	Land	Facilities*	Land	
Macedonia	$ 52,628	$ 1,080	$ 21,719	$ 10,875	$ 25,197	$ 12,617	$ 91,522
Minden	57,672	1,230	26,640	13,339	28,506	14,273	101,681
Neola	104,643	3,120	60,491	30,288	73,980	37,043	218,786
Oakland	128,500	4,650	91,458	45,794	109,868	55,012	298,030
Treynor	123,840	4,320	67,702	33,899	102,656	51,401	282,217
Underwood	88,064	2,310	41,063	20,560	54,637	27,357	172,368
Walnut	73,381	1,770	41,063	20,560	41,062	20,560	136,773
Emerson	63,448	1,860	29,015	14,528	36,566	18,309	120,183
Malvern	81,088	2,040	51,752	25,913	47,850	23,959	154,937
Tabor	95,017	2,610	53,704	26,890	62,357	31,223	191,207
Waterloo	75,888	1,860	30,627	15,335	48,444	24,256	150,448
Total	$2,466,121	$66,420	$1,371,097	$686,518	$1,589,729	$795,990	$4,918,260

*If grid under drainage is not required, these costs may be reduced to 0.550 times the stated value.

TABLE 54

LAND TREATMENT CAPITAL COST

Treatment Plants	Storage Cost								Irrigation Cost																							
	2020								1995								2020								Total			
	Facilities				Land				Facilities*				Land				Facilities*				Land							
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Minor Urban																												
E. Bellevue	-	279	-	-	-	13	-	-	-	313	-	-	-	220	-	-	-	331	-	-	-	233	-	-	-	836	-	-
Deer Creek	-	279	-	-	-	13	-	-	-	223	-	-	-	157	-	-	-	331	-	-	-	233	-	-	-	836	-	-
Bennington	206	909	206	206	8	65	8	8	142	1,193	142	142	99	840	99	99	201	1,742	201	201	141	1,226	141	141	354	3,942	354	354
Elkhorn	483	909	228	228	28	65	10	10	168	1,193	168	168	118	840	118	118	741	1,742	267	267	522	1,226	188	188	1,774	3,942	693	693
Valley	228	370	228	228	10	19	10	10	206	400	206	206	145	281	145	145	275	493	275	275	193	347	193	193	706	1,229	706	706
Bovetown	148	133	176	148	5	4	7	5	73	85	99	73	51	60	70	51	137	103	168	137	96	72	118	96	386	317	469	386
Springfield	300	1,022	300	300	14	77	14	14	176	1,592	176	176	124	1,121	124	124	364	2,052	364	364	257	1,445	257	257	935	4,596	935	935
Gretna	477	1,290	477	752	27	108	27	49	468	1,987	468	468	329	1,399	329	329	743	2,868	743	1,344	523	2,019	523	946	1,770	6,285	1,770	1,091
Blair	525	1,152	525	525	32	91	32	32	743	1,911	743	743	523	1,345	523	523	846	2,464	846	846	595	1,735	595	595	1,998	5,662	1,998	1,998
Fort Calhoun	156	428	156	156	6	24	6	6	108	477	108	108	76	336	76	76	138	656	138	138	97	462	97	97	397	1,570	397	397
Plattsmouth	428	860	428	428	24	61	24	24	609	1,592	609	609	429	1,121	429	429	661	1,667	661	661	466	1,174	466	466	1,579	3,762	1,579	1,579
Missouri Valley	286	525	286	286	13	32	13	13	313	795	313	313	220	560	220	220	356	820	356	356	251	577	251	251	906	1,934	906	906
Glenwood	257	525	257	257	12	32	12	12	322	795	322	322	227	560	227	227	296	820	296	296	208	577	208	208	773	1,934	773	773
Subtotal	3,492	8,683	3,265	3,512	179	604	163	183	3,328	12,556	3,354	3,328	2,341	8,840	2,360	2,341	4,758	16,089	4,315	4,885	3,349	11,326	3,037	3,438	11,778	36,700	10,780	12,018
Non-Urban	2,466	2,466	2,466	2,466	66	66	66	66	1,370	1,370	1,370	1,370	687	687	687	687	1,589	1,589	1,589	1,589	797	797	797	797	4,918	4,918	4,918	4,918
Total	5,958	11,149	5,731	5,978	245	670	229	249	4,698	13,926	4,724	4,698	3,028	9,527	3,047	3,028	6,347	17,678	5,904	6,474	4,146	12,123	3,834	4,235	16,696	41,618	15,698	16,936

*If grid underdrainage is not required, these values may be reduced to 0.550 times the stated value.

TABLE 55

PLAN 3
TOTAL PRESENT WORTH SUMMARY
(x $1,000,000)

	Level 1				Level 2				Level 3			
	Concepts				Concepts				Concepts			
	A	B	C	D	A	B	C	D	A	B	C	D
PAPILLION												
Wastewater, Major Urban	62.7	33.4	57.1	68.5	99.4	55.6	90.2	100.0	101.9	48.7	93.0	103.9
Wastewater, Minor Urban	*	*	*	*	6.7	25.6	6.5	7.3	6.7	25.6	6.5	7.3
Stormwater, Not Combined-Upsystem	92.7	94.3	90.5	97.5	92.7	94.3	90.5	97.5	119.7	122.8	110.2	131.5
Stormwater, Combined-Upsystem	51.6	54.3	43.7	41.7	51.6	54.3	43.7	41.7	64.8	67.9	54.6	58.0
Stormwater, Combined-Conveyance	76.3	74.3	64.6	62.2	76.3	74.3	64.6	62.2	79.5	77.5	66.8	64.6
Interceptor, Total	8.3	5.8	4.8	7.2	8.3	5.8	4.8	7.2	8.3	5.8	4.8	7.2
Interceptor, Just Combined (Δ)	7.5	5.3	7.1	6.7	7.5	5.3	7.1	6.7	7.5	5.3	7.1	6.7
MISSOURI RIVER												
Wastewater	65.3	64.4	69.6	57.6	93.4	92.0	110.6	93.9	107.0	104.8	114.9	107.7
Stormwater, Combined-Upsystem	196.1	195.8	189.4	199.3	196.1	195.8	189.4	199.3	259.7	248.6	249.5	246.8
Stormwater, Combined-Tunnel	129.0	129.2	129.7	129.9	129.0	129.2	129.7	129.9	132.5	132.8	133.7	133.1
Interceptor, Total	(	Use Existing		)	(	Use Existing		)	(	Use Existing		)
COUNCIL BLUFFS												
Wastewater	23.7	22.1	23.8	23.7	32.5	30.3	32.7	32.4	36.0	33.6	36.2	35.4
Stormwater, Not Combined-Upsystem	8.2	9.9	7.7	9.6	8.2	9.9	7.7	9.6	11.2	13.0	11.1	14.9
Stormwater, Combined-Upsystem	8.9	8.7	8.4	7.9	8.9	8.7	8.4	7.9	9.9	9.7	9.3	8.8
Stormwater, Combined-Conveyance	11.3	11.5	10.8	10.5	11.3	11.5	10.8	10.5	11.5	11.8	11.1	10.9
Interceptor, Total	(	Use Existing	)	0.1	(	Use Existing	)	0.1	(	Use Existing	)	0.1
Interceptor, Just Combined (Δ)	2.0	1.4	2.0	1.3	2.0	1.4	2.0	1.3	2.0	1.4	2.0	1.3
ADDITIONAL AREAS												
Wastewater	*	*	*	*	36.4	65.8	37.6	37.1	36.4	65.8	37.6	37.1
Stormwater, Not Combined-Upsystem	2.9	4.1	2.5	4.4	2.9	4.1	2.5	4.4	3.8	5.6	3.9	4.0
STORMWATER LAND AND SLUDGE HANDLING CAPITAL												
Papillion, Not Combined-Upsystem	3.7	2.9	3.2	4.0	3.7	2.9	3.2	4.0	4.1	3.3	3.5	4.5
Papillion, Combined-Upsystem	0.8	0.8	0.7	0.5	0.8	0.8	0.7	0.5	1.0	1.0	0.5	0.6
Remaining, Not Combined-Upsystem	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4
Remaining, Combined-Upsystem	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.2
Missouri River, Combined-Upsystem	2.8	2.7	2.8	2.9	2.8	2.7	2.8	2.9	3.3	3.2	3.4	3.5

*No Level 1 in land treatment

1. For 1985 - storage facilities are constructed for 2020 flows.

   - land and facilities are constructed for 1990 flows.

2. For 1990 and 2020 - facilities are added every five years to accommodate the next five-year increment.

The tables, as presented, represent the conservative land treatment approach assuming that the land must be purchased and underdrained. Site-by-site investigations are required to determine whether underdrainage is required and what institutional arrangements would best implement the land process. A factor of 0.555 may be applied to the capital and present worth tables to show the cost of the system without underdrainage.

MAJOR LAND TREATMENT OPTIONS

Description

Since secondary treatment was shown to not contravene standards in the Missouri River under certain conditions, options for a major land treatment system are presented to show the possibilities of large scale irrigation. The option presumes irrigation with secondary effluent during summer and discharge to the Missouri River in the winter. The winter storage requirements are therefore eliminated and only storage to allow for non-uniform application is required.

This major land treatment option was not considered as a full alternative plan because it can be developed for any of the 3 final plans as an addition to the Level 1 treatment of the major urban plants.

Several variations exist when considering three major plants and two major land masses applicable to land treatment. Some of these variations are costed in this section. Three main options are considered. Option 1 envisions all of the 1995 flow transported to Priority 1 sites and future flows taken to Priority 2 sites. Option 2 takes all flow to Priority 1 sites and Option 3 takes all flow to Priority 2 sites.

Another variable considered the number of treatment plants involved in land treatment. The combinations presented are: Papillion, Missouri River, and Council Bluffs; Papillion and Missouri River; Papillion; and an increment is developed if the Papillion sewer system is extended rather than limited.

Plate 9 at the end of this section illustrates the major land

treatment options.

Costs

Table 56 shows the phased capital costs for Option 1. The costs for Options 2 and 3 are shown in Appendix D. The phasing of the costs is primarily the same as in the smaller land treatment sites. However, due to size, the storage costs are phased with a portion in 1985 and the remainder in 1995. The irrigation facilities are placed in five-year increments.

The O&M is based primarily on flow, using the same values as in the Phase I report.

The present worth of Option 1 is shown in Tables 57 through 60, illustrating the costs associated with the various combinations of treatment plants to land treatment. All the component costs are presented with three totals presented for each option. The maximum total represents a system in which grid underdrainage is required on all land and the land costs are borne by a central institution for land treatment. The intermediate total represents the case where grid underdrainage would not be required. The minimum total represents no underdrainage and no land cost. Other totals can be derived from the table depending on the institutional arrangements prescribed in future studies.

TABLE 56

LAND TREATMENT CAPITAL COSTS
OPTION 1
(x $1,000)

Treatment Plants*	1985 A	1985 B	1985 C	1985 D	1990 A	1990 B	1990 C	1990 D	1995 A	1995 B	1995 C	1995 D	2000-2015(4Δ) A	2000-2015(4Δ) B	2000-2015(4Δ) C	2000-2015(4Δ) D	Total A	Total B	Total C	Total D
PL+M+CB																				
Irrigation-Facilities	31,574	28,163	31,687	25,029	8,648	5,284	8,833	9,376	4,176	3,586	3,995	3,753	4,176	3,586	3,995	3,753	61,102	51,377	60,495	53,170
Land	32,384	28,891	32,499	33,123	8,869	5,421	9,060	9,616	5,644	4,845	5,399	5,071	5,644	4,845	5,399	5,071	69,473	58,537	68,554	68,094
Storage-Facilities	8,880	7,721	8,962	9,205	-	-	-	-	5,423	4,901	5,269	4,984	-	-	-	-	14,303	12,622	14,231	14,189
Land	906	754	912	938	-	-	-	-	495	426	475	446	-	-	-	-	1,401	1,180	1,387	1,384
Conveyance	18,902	17,543	18,902	18,902	-	-	-	-	16,800	14,933	16,800	16,800	-	-	-	-	35,702	32,476	35,702	35,702
Total	92,646	83,072	92,962	87,197	17,517	10,705	17,893	18,992	32,538	28,691	31,938	31,054	9,820	8,431	9,394	8,824	181,981	156,192	180,369	172,539
PL+M																				
Irrigation-Facilities	27,475	24,356	27,621	28,324	7,347	4,265	7,476	8,223	3,332	2,838	3,154	2,844	3,322	2,838	3,154	2,844	51,482	42,811	50,867	50,767
Land	28,179	24,980	28,330	29,050	7,536	4,374	7,677	8,434	4,502	3,836	4,262	3,843	4,502	3,836	4,262	3,843	58,225	48,534	57,307	56,699
Storage-Facilities	7,433	6,394	7,508	7,799	-	-	-	-	4,173	3,770	4,023	3,669	-	-	-	-	11,606	10,164	11,531	11,468
Land	784	645	790	823	-	-	-	-	395	337	375	338	-	-	-	-	1,179	982	1,165	1,161
Conveyance	16,802	14,331	15,319	16,802	-	-	-	-	10,080	8,400	8,400	10,080	-	-	-	-	26,882	22,731	23,719	26,882
Total	80,673	70,706	79,568	82,798	14,883	8,639	15,143	16,65[illegible]	22,482	19,181	20,214	20,774	7,834	6,674	7,416	6,687	149,374	125,222	144,589	146,977
PL																				
Irrigation-Facilities	13,748	11,249	13,162	14,389	5,616	3,154	5,068	6,255	2,499	1,779	2,141	2,097	2,499	1,779	2,141	2,097	31,859	23,298	28,935	31,129
Land	14,101	11,537	13,500	14,758	5,760	3,235	5,198	6,416	3,377	2,404	2,893	2,833	3,377	2,404	2,893	2,833	36,746	26,792	33,163	35,339
Storage-Facilities	4,078	3,218	3,956	4,348	-	-	-	-	2,941	2,272	2,592	2,539	-	-	-	-	7,019	5,490	6,548	6,887
Land	436	325	410	465	-	-	-	-	297	211	255	249	-	-	-	-	733	536	665	714
Conveyance	14,331	13,095	14,331	14,331	-	-	-	-	13,253	11,947	13,253	13,253	-	-	-	-	27,584	25,042	27,584	27,584
Total	46,694	39,424	45,359	48,291	11,376	6,389	10,266	12,761	22,367	18,613	21,134	20,971	5,876	4,183	5,034	4,930	103,941	81,158	96,895	101,653
PE-PL																				
Irrigation-Facilities	493	1,875	592	493	537	1,846	536	471	137	293	31	283	137	29[illegible]	31	283	1,715	5,186	1,283	2,379
Land	506	1,924	607	506	550	1,890	549	483	185	396	42	218	185	396	42	218	1,981	5,794	1,366	2,079
Storage-Facilities	217	715	121	203	-	-	-	-	161	237	37	119	-	-	-	-	378	952	158	322
Land	24	83	26	22	-	-	-	-	15	35	103	19	-	-	-	-	39	118	129	41
Conveyance	988	1,236	0	988	-	-	-	-	0	1,306	0	0	-	-	-	-	988	2,542	0	988
Total	2,228	5,833	1,346	2,212	1,087	3,736	1,085	954	498	2,267	213	639	322	689	73	501	5,101	14,592	2,936	5,809

*M - Missouri River STP
CB - Council Bluffs STP
PL - Papillion STP limited Sewer
PE - Papillion STP extended Sewer

TABLE 57

PRESENT WORTH OF LAND TREATMENT

OPTION 1
($1,000)

To Land Treatment

PAPILLION

Component	Growth Concept			
	A	B	C	D
Irrigation Facilities	7,650	5,777	7,136	7,877
Irrigation and Drainage	13,884	10,485	12,951	14,296
Storage Facilities	3,424	2,687	3,244	3,473
Land Irrigation	12,611	9,502	11,734	12,909
Land Storage	332	243	305	335
Conveyance	11,299	10,212	11,236	11,268
O&M of Irrigation Facilities	12,706	9,574	12,451	13,062
O&M of Conveyance	8,384	6,302	7,786	8,522
Maximum Total	62,640	49,005	59,707	63,865
Intermediate Total	50,029	39,503	48,073	50,956
Minimum Total	43,795	34,795	42,159	44,537

TABLE 58

PRESENT WORTH OF LAND TREATMENT

OPTION 1
($1,000)

To Land Treatment

PAPILLION
MISSOURI

Component	Growth Concept			
	A	B	C	D
Irrigation Facilities	13,912	11,419	13,592	13,909
Irrigation and Drainage	25,249	20,724	24,667	25,243
Storage Facilities	5,886	5,117	5,889	5,965
Land Irrigation	22,200	18,661	22,478	22,645
Land Storage	560	463	558	567
Conveyance	15,739	13,288	14,216	15,588
O&M of Irrigation Facilities	22,460	18,851	22,478	23,002
O&M of Conveyance	14,651	12,328	14,618	14,892
Maximum Total	106,745	89,432	104,902	107,902
Intermediate Total	84,545	70,771	82,424	85,257
Minimum Total	73,208	61,466	71,349	73,923

TABLE 59

PRESENT WORTH OF LAND TREATMENT

OPTION 1
($1,000)

To Land Treatment

PAPILLION
MISSOURI
COUNCIL BLUFFS

Component	Growth Concept			
	A	B	C	D
Irrigation Facilities	15,811	13,425	15,822	13,367
Irrigation and Drainage	28,696	24,364	28,715	24,260
Storage Facilities	7,165	6,284	7,169	7,236
Land Irrigation	25,397	21,988	26,386	26,759
Land Storage	658	550	656	663
Conveyance	24,082	22,295	23,915	23,907
O&M of Irrigation Facilities	26,153	22,184	26,170	26,593
O&M of Conveyance	17,112	14,559	17,089	17,308
Maximum Total	129,263	112,224	130,100	126,725
Intermediate Total	103,866	90,236	103,714	99,967
Minimum Total	90,981	79,297	90,821	89,074

TABLE 60

PRESENT WORTH OF LAND TREATMENT

OPTION 1

($1,000)

To Land Treatment

PAPILLION EXTENSION - PAPILLION LIMITED

Component	Growth Concept A	B	C	D
Irrigation Facilities	379	1,294	369	425
Irrigation and Drainage	687	2,349	670	772
Storage Facilities	183	516	86	161
Land Irrigation	627	2,116	594	622
Land Storage	17	57	42	17
Conveyance	676	1,025	16	596
O&M of Irrigation Facilities	632	2,163	613	622
O&M of Conveyance	414	1,392	391	426
Maximum Total	3,236	9,618	2,412	3,216
Intermediate Total	2,609	7,502	1,818	2,594
Minimum Total	2,301	6,447	1,517	2,247

SUMMARY OF PLAN COSTS

The component present worth Tables 48, 52, and 55 can be used to develop several sub-alternatives to each plan. This section summarizes the three final plans and develops costs for certain other viable plans. Each table presents a cost for a specific plan for the three levels of treatment and four growth concepts. All the costs represent plans which will meet water quality standards using historical flows.

Final Plans

Table 61 summarizes the cost of the final three plans (1, 2, and 3) as presented in the previous sections. The costs shown are based on the following assumptions:

1. Level 1 stormwater treatment is associated with Level 1 and 2 wastewater treatment.
2. Level 2 stormwater treatment is associated with Level 3 wastewater treatment.
3. Separate stormwater is treated at individual upstream sites.
4. Combined sewer overflow in the Omaha-Missouri River area is conveyed to the Missouri River Plant.
5. Other combined areas are shown two ways; individual upsystem treatment or conveyance to the appropriate treatment plant for treatment (two totals are presented).

TABLE 61

PLAN COST SUMMARY TABLE

	Level 1				Level 2				Level 3			
	A	B	C	D	A	B	C	D	A	B	C	D
PLAN 1												
Wastewater	187.2	205.7	187.2	179.1	269.9	295.6	280.8	269.9	308.3	339.6	309.3	307.7
Stormwater**	301.0	307.5	289.6	298.9	301.0	307.5	289.6	298.9	282.1	360.0	331.0	359.5
Interceptor	10.3	8.4	7.8	8.5	10.3	8.4	7.8	8.5	10.3	8.4	7.8	8.5
Total	498.5	521.6	484.6	486.5	581.2	611.5	578.2	577.3	669.4	708.0	648.1	675.7
Δ Cost of Conveyance of Combined Basins to WWTP	35.2	30.3	31.4	30.9	35.2	30.3	31.4	30.9	23.6	18.4	21.3	15.6
New Total	533.7	551.9	516.0	517.4	616.4	641.8	609.6	608.2	692.0	726.4	669.4	691.3
PLAN 2												
Wastewater	185.2	184.1	184.0	183.3	268.4	271.8	276.6	269.4	297.7	291.3	296.9	299.8
Stormwater**	301.0	307.5	289.6	298.9	301.0	307.5	289.6	298.9	282.1	360.0	331.0	359.5
Interceptor	8.3	5.8	4.8	7.3	8.3	5.8	4.8	7.3	8.3	5.8	4.8	7.3
Total	494.5	497.4	478.4	489.5	577.7	585.1	571.0	575.6	656.8	657.1	632.7	666.6
Δ Cost of Conveyance of Combined Basins to WWTP	32.9	25.8	28.8	27.6	32.9	25.8	28.8	27.6	21.3	13.9	18.7	12.3
New Total	527.4	523.2	507.2	517.1	610.6	610.9	599.8	603.2	678.1	671.0	651.4	678.9
PLAN 3												
Wastewater	*	*	*	*	268.4	269.3	277.6	270.7	288.0	278.5	288.2	291.4
Stormwater**	*	*	*	*	301.0	307.5	289.6	298.9	282.1	360.0	331.0	359.5
Interceptor	*	*	*	*	8.3	5.8	4.8	7.3	8.3	5.8	4.8	7.3
Total	*	*	*	*	577.7	582.6	572.0	576.9	647.1	644.3	624.0	658.2
Δ Cost of Conveyance of Combined Basins to WWTP	*	*	*	*	32.9	25.8	28.8	27.6	21.3	13.9	18.7	12.3
New Total	*	*	*	*	610.6	608.4	600.8	604.5	668.4	658.2	642.7	670.5

*Land treatment provides better than Level 1 treatment
**Includes Missouri River Tunnel instead of Missouri River Upsystem

Plan 3 with Mixed Treatment Levels

Table 62 shows the costs for a mixed level plan based on Plan 3. In this option, costs are presented as in Plan 3 except that Level 1 wastewater treatment costs for the major urban treatment plants discharging to the Missouri River are combined with land treatment costs for the minor and non-urban locations. This combination provides higher treatment at all upstream discharges which may become necessary as individual systems are analyzed for water quality requirements.

Plan 3 with Major Land Option

Table 63 shows the costs of providing summer irrigation using the major urban plant effluents. This combination provides effluent qualities comparable to Level 2 and 3 treatment in the three base plans.

TABLE 62

PLAN 3
MIXED TREATMENT LEVELS
PRESENT WORTH
(x $1,000,000)

	Concepts A	B	C	D
Plan 3 (Level 1)	494.5	497.4	478.4	489.5
Plan 3 (Level 1) with Option	504.1	524.6	489.0	500.4

TABLE 63

PLAN 3
MAJOR LAND OPTIONS
PRESENT WORTH
(x $1,000,000)

	Concepts A	B	C	D
Level 2				
Plan Without Option 1	577.7	582.6	572.0	576.9
Plan With Option 1				
Minimum Cost	595.1	603.8	579.8	588.9
Maximum Cost	633.4	636.7	619.1	626.2
Level 3				
Plan Without Option 1	647.1	644.3	624.0	658.2
Plan With Option 1				
Minimum Cost	644.9	656.3	621.2	649.5
Maximum Cost	683.2	689.2	660.5	687.2

IMPACT PARAMETERS

Irrigation Potential

Plan 3 and the Major Land Option both use land treatment techniques as part of wastewater management. This section presents the impact parameters associated with this technology. These include:

Quantity of irrigation water

Quality of irrigation water

Land required

Quantity of Irrigation Water - Tables 64 and 65 show the quantity of secondary effluent produced and subject to land treatment in the non-urban and minor urban plants associated with Plan 3. Table 66 shows the quantity of secondary effluent available with the major land treatment option for the various combinations of major urban wastewater treatment plants.

TABLE 64

IRRIGATION WATER QUANTITIES
NON URBAN SITES

Non Urban Sites	Quantity (Ac-Ft/day) All Concepts 1985	2020
Washington County, Nebraska		
Arlington	0.35	0.49
Herman	0.10	0.10
Kennard	0.10	0.10
Cass County, Nebraska		
Weeping Water	0.38	0.49
Union	0.08	0.07
Nehawka	0.10	0.15
Murray	0.09	0.11
Murdock	0.09	0.11
Manley	0.05	0.06
Louisville	0.29	0.27
Greenwood	0.21	0.37
Elmwood	0.07	0.30
Eagle	0.19	0.33
Avoca	0.08	0.10
Alvo	0.04	0.04
Douglas County, Nebraska		
Waterloo	0.15	0.28
Harrison County, Iowa		
Logan	0.50	0.62
Woodbine	0.47	0.62
Mondamin	0.12	0.11
Dunlap	0.42	0.51
Pisgah	0.09	0.10
Pottawattamie County, Iowa		
Avoca	0.45	0.47
Carson	0.25	0.31
Hancock	0.08	0.10
Macedonia	0.12	0.16
Minden	0.15	0.18
Neola	0.33	0.47
Oakland	0.52	0.70
Treynor	0.28	0.65
Underwood	0.19	0.35
Walnut	0.26	0.26

TABLE 64 (CONT'D.)

IRRIGATION WATER QUANTITIES
NON URBAN SITES - CONTINUED

Non Urban Sites	Quantity (Ac-Ft/day) All Concepts 1985	2020
Mills County, Iowa		
Emerson	0.16	0.21
Malvern	0.33	0.30
Tabor	0.31	0.40
Total	7.40	9.89

TABLE 65

IRRIGATION WATER QUANTITIES
MINOR URBAN SITES

Growth Concept	Quantity (Ac-Ft/day)							
	1985				2020			
Minor Urban Sites	A	B	C	D	A	B	C	D
Bennington	0.60	4.36	0.60	0.60	1.44	12.37	1.44	1.44
Elkhorn	0.77	4.43	0.77	0.77	5.28	12.37	1.90	1.90
Valley	1.06	1.75	1.06	1.06	1.96	3.53	1.96	1.96
Boys Town	0.37	0.41	0.37	0.37	0.98	0.74	1.20	0.98
Springfield	0.75	5.82	0.75	0.75	2.61	14.67	2.61	2.61
Gretna	1.90	7.33	1.90	1.90	5.31	20.53	5.31	9.61
Blair	3.64	7.81	3.64	3.64	6.05	17.62	6.05	6.05
Fort Calhoun	0.97	2.29	0.97	0.97	1.01	4.70	1.01	1.01
Plattsmouth	3.10	6.61	3.10	3.10	4.73	11.75	4.73	4.73
Missouri Valley	3.25	3.35	3.25	3.25	2.55	5.86	2.55	2.55
Glenwood	1.81	3.50	1.81	1.81	2.12	5.86	2.12	2.12
Deer Creek	-	0.80	-	-	-	2.36	-	-
East Bellevue	-	1.12	-	-	-	2.36	-	-
Total	18.22	49.58	18.22	18.22	34.04	114.72	30.88	34.96

TABLE 66

IRRIGATION WATER QUANTITY
MAJOR LAND TREATMENT OPTIONS
Quantity (ac-ft/yr*)

Supply	1985				2020			
	A	B	C	D	A	B	C	D
Papillion - Limited (PL)	34,638	28,340	33,146	36,212	81,929	59,879	74,322	79,816
Papillion - Extended (PE)	35,881	33,063	34,638	37,455	86,338	73,146	77,570	84,382
PL+Missouri River STP (M)	69,193	61,321	69,524	71,347	131,914	109,747	130,240	129,778
PL+M+Council Bluff STP	79,468	70,933	79,800	81,291	156,724	131,839	155,066	154,743

*270 Days/Year.

Quality of Irrigation Water - Tables 67 and 68 show the quality of the wastewater effluent provided in Plan 3 and the Major Land Option, respectively. Table 67 presents various parameters and their quantities as presented both in the literature and in the designs developed for this study. These values apply to the non-urban and minor urban plants sources in Plan 3 which are predominantly residential in nature. Table 68 shows values measured in grab samples of the major urban plants associated with the Major Land Option. A continuous sampling program is required to determine annual loads but the table indicates the problems associated with the industrial components of the urban wastes.

The irrigation water quality of the major land treatment options are classified below based upon the Nebraska Water Quality Standards for irrigation use. These standards state that "the SAR value and conductivity shall not be greater than a C3-S2 Class irrigation water as shown in Figure 25 of the Agricultural Handbook 60, U.S. Dept. of Agriculture". Council Bluffs alone (C3-S4) is greater than the standard irrigation water; the Papillion Plant alone (C2-S1) is less than the standard; and the other wastewater plant combinations (C3-S2) of Table 68, meet the standards.

TABLE 67

IRRIGATION WATER QUALITY
PLAN 3

Parameter	Concentration* (mg/l)	#/Acre/Year
BOD	30**	
SS	30**	
TDS	500	
P	7-8**	52-60
N	18-28**	135-209
K	14	105
Na	50	
Ca	24	
Mg	17	
SAR	2	
pH	7±	

*Wastewater Treatment and Reuse by Land Application - Vol. II, USEPA, August, 1973.

**Developed in this Study.

TABLE 68

IRRIGATION WATER QUALITY
MAJOR LAND TREATMENT OPTION
(mg/1)

	1995 Avg. Flow (mgd)	Na	Ca	Mg	TDS	SAR	P		N	
							mgl	#/ac*	mgl	#/ac
Papillion STP (PL)	55	175	46	21	704	5	6	43	26	188
Missouri River STP (M)	47	340	61	18	1,111	10	5	36	33	239
Council Bluffs (CB)	16	484	47	26	1,686	14	4	36	34	246
PL+M+CB	118	283	52	20	999	8	5.5	40	30	217
PL+M	102	251	53	20	892	7	5.5	40	29	210

* Using 33" of Water Per Year

Land Requirements - Tables 69, 70 and 71 show the land required for irrigation and storage in the non-urban and minor urban sites associated with Plan 3 and in the western sites associated with the Major Land Option, respectively.

TABLE 69

LAND TREATMENT AREA REQUIREMENTS
NON-URBAN PLANTS

Non-Urban Wastewater Treatment Plants	Irrigated Land Requirements (acres) 1995	Irrigated Land Requirements (acres) 2020	Storage: Surface Area (acres) 1995	Storage: Surface Area (acres) 2020	Storage: Land Area (acres) 1995	Storage: Land Area (acres) 2020
Arlington	79.8	90.7	6.3	7.2	9.5	10.8
Herman	18.2	17.6	1.5	1.4	2.3	2.1
Kennard	20.0	19.3	1.6	1.5	2.4	2.3
Weeping Water	81.6	90.7	6.5	7.2	9.8	10.8
Union	14.3	13.7	1.1	1.1	1.7	1.7
Nehawka	22.8	28.0	1.8	2.2	2.7	3.3
Murray	19.3	20.6	1.5	1.6	2.3	2.4
Murdock	18.8	20.6	1.5	1.6	2.3	2.4
Manley	10.8	12.0	8.6	1.0	12.9	1.5
Louisville	53.1	50.8	4.2	4.0	6.3	6.0
Greenwood	51.4	69.0	4.1	5.5	6.2	8.3
Elmwood	45.1	56.4	3.6	4.5	5.4	6.8
Eagle	46.2	61.6	3.7	4.9	5.6	7.4
Avoca	16.0	17.6	1.3	1.4	2.0	2.1
Alvo	8.0	8.0	0.6	0.6	0.9	0.9
Logan	117.3	128.8	8.4	9.2	12.6	13.8
Woodbine	101.0	128.8	8.0	9.2	12.0	13.8
Mondamin	23.4	20.0	1.9	1.6	2.9	2.4
Dunlap	87.8	94.6	7.0	7.5	10.5	11.5
Pisgah	18.2	19.3	1.5	1.5	2.3	2.3
Avoca	86.1	87.2	6.8	6.9	10.2	10.4
Carson	53.6	57.0	4.3	4.5	6.5	6.8
Hancock	16.0	17.6	1.3	1.4	2.0	2.1
Macedonia	25.6	29.7	2.0	2.4	3.0	3.6
Minden	31.4	33.6	2.5	2.7	3.8	4.1
Neola	71.3	87.2	5.7	6.9	8.6	10.4
Oakland	107.8	129.5	8.6	10.3	12.9	15.5
Treynor	79.8	121.0	6.3	9.6	9.5	14.4
Underwood	48.4	64.4	3.9	5.1	5.9	7.7
Walnut	48.4	48.4	3.9	3.9	5.9	5.9
Emerson	34.2	43.1	2.7	3.1	4.1	6.2
Malvern	61.0	56.4	4.9	4.5	7.4	6.8
Tabor	63.3	73.5	5.0	5.8	7.5	8.7
Waterloo	36.1	57.1	2.6	4.1	3.9	6.2
Total	1,616.1	1,873.8	135.2	145.9	203.8	221.4

TABLE 70

LAND TREATMENT AREA REQUIREMENTS

Treatment Plants	Irrigated Land Requirements (Acres) 1995 A	1995 B	1995 C	1995 D	2020 A	2020 B	2020 C	2020 D
Minor Urban								
E Bellevue	-	416	-	-	-	440	-	-
Deer Creek	-	297	-	-	-	440	-	-
Bennington	188	1,585	188	188	267	2,286	267	267
Elkhorn	223	1,585	223	223	981	2,286	354	354
Valley	274	531	274	274	365	655	365	365
Boystown	97	113	132	97	182	137	223	182
Springfield	234	2,115	234	234	484	2,726	484	484
Gretna	622	2,640	622	622	987	3,809	987	1,785
Blair	987	2,538	987	987	1,123	3,273	1,123	1,123
Fort Calhoun	143	633	143	143	183	872	183	183
Plattsmouth	809	2,115	809	809	878	2,215	878	878
Missouri Valley	416	1,056	416	416	473	1,089	473	473
Glenwood	428	1,056	428	428	393	1,089	393	393
Subtotal	4,421	16,680	4,456	4,421	6,316	21,317	5,730	6,487
Non-Urban	1,616	1,616	1,616	1,616	1,874	1,874	1,874	1,874
Total	6,037	18,296	6,072	6,037	8,190	23,191	7,604	8,361

Treatment Plants	2020 Storage Surface Area (Acres) A	B	C	D	2020 Storage Land Area (Acres) A	B	C	D	2020 Total (Acres) A	B	C	D
Minor Urban												
E Bellevue	-	21	-	-	-	32	-	-	-	472	-	-
Deer Creek	-	21		-	-	32	-	-	-	472	-	-
Bennington	13	107	13	13	20	160	20	20	287	2,446	287	287
Elkhorn	46	107	16	16	69	160	24	24	1,050	2,446	378	378
Valley	16	32	16	16	24	48	24	24	389	703	389	389
Boystown	8	7	11	8	12	11	17	12	194	148	240	194
Springfield	24	128	24	24	36	192	36	36	520	2,918	520	520
Gretna	45	179	45	83	68	269	68	125	1,055	4,078	1,055	1,910
Blair	53	152	53	53	80	228	80	80	1,203	3,501	1,203	1,203
Fort Calhoun	9	40	9	9	14	60	14	14	197	932	197	197
Plattsmouth	40	101	40	40	60	152	60	60	938	2,367	938	938
Missouri Valley	21	53	21	21	32	80	32	32	505	1,169	505	505
Glenwood	19	53	19	19	29	80	29	29	422	1,169	422	422
Subtotal	294	991	267	302	444	1,504	404	456	6,760	22,821	6,134	6,943
Non-Urban	146	146	146	146	221	221	221	221	2,095	2,095	2,095	2,095
Total	440	1,137	413	448	665	1,725	625	677	8,855	24,916	8,229	9,036

TABLE 71

LAND TREATMENT AREA REQUIREMENTS MAJOR URBAN LAND OPTIONS

Priority 1 (by 1995)

Treatment Plants*	Irr. Land Req'd. (ac)				Storage Surface (ac)				Storage Land (ac)				Total Land			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
M	19,818	18,228	21,624	20,388	580	534	633	597	870	801	950	896	20,688	19,029	22,574	21,284
CB	6,923	6,198	6,952	6,569	203	181	204	192	305	272	306	288	7,228	6,470	7,258	6,857
PE	26,146	23,236	24,818	27,703	766	680	727	811	1,149	1,020	1,091	1,717	27,295	24,256	25,909	29,420
PL	24,826	18,465	23,372	26,467	727	541	684	775	1,091	812	1,026	1,163	25,917	19,277	24,398	27,630
PL+M+CB	51,567	42,891	51,948	53,422	1,510	1,256	1,521	1,564	2,266	1,885	2,282	2,347	53,833	44,776	54,230	55,769
PL+M	44,644	36,693	44,996	46,855	1,307	1,075	1,307	1,372	1,961	1,613	1,976	2,059	46,605	38,306	46,972	48,914
PE-PL	1,320	4,771	1,446	1,236	39	139	43	36	58	208	65	554	1,378	4,979	1,511	1,790

Priority 2 (1995-2020)

Treatment Plants*	Irr. Land Req'd. (ac)				Storage Surface (ac)				Storage Land (ac)				Total Land			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
M	5,628	7,160	6,844	5,046	165	210	200	148	248	315	300	222	5,876	7,475	7,144	5,268
CB	5,708	5,048	5,687	6,142	167	148	167	180	251	222	251	270	5,959	5,270	5,938	6,412
PE	17,808	14,001	14,672	15,255	521	410	430	447	782	615	645	670	18,590	14,616	15,317	15,925
PL	16,883	12,019	14,464	14,167	494	352	424	415	741	528	636	623	17,624	12,547	15,100	14,790
PL+M+CB	28,219	24,227	26,995	25,355	359	710	791	743	1,240	1,065	936	1,115	29,459	25,292	27,931	26,470
PL+M	22,511	19,179	21,308	19,213	192	562	624	563	989	843	1,187	845	23,500	20,022	22,495	20,058
PE-PL	975	1,982	208	1,088	27	58	6	32	41	87	9	47	1,016	2,068	217	1,135

*M - Missouri River STP
CB - Council Bluffs STP
PE - Papillion STP Extended Sewer
PL - Papillion STP Limited Sewer

Energy and Resource Requirements

Electrical Requirements - One of the resource requirements to be considered in the environmental assessment of the final alternative plans is the electrical energy requirements. These requirements have been estimated for the major, minor, and non-urban wastewater treatment plants as illustrated in Table 72, and are based on data from design reports, previous studies, and other sources.

This table shows that for the Level 1 treatment there is no essential difference between the plans. There is an incremental increase to Level 2 treatment, as would be expected, due to the increased requirements to achieve nitrification. Also, additional electrical energy is required for land application of the minor and non-urban plants of Plan 3, Level 2. This increase is mainly due to pumping requirements to reach the land treatment site from the wastewater treatment plant.

Table 73 illustrates the effect of the Major Land Treatment options on the major urban plants of Plan 3. There is a significant increase in electrical requirements due to the pumping requirements to transport the wastewater to the Todd Valley land treatment site. It should be noted that the electrical requirements for the other priority land treatment sites in the Big Blue River basin would be even higher due to the increase in distance and elevation. Growth Concept B (Satellite Cities) has noticeably lower electrical power requirements than the other Growth Concepts due to the lesser amount of wastewater being taken to the major land treatment sites.

TABLE 72

1995 ANNUAL AVERAGE
ELECTRICAL POWER REQUIREMENTS
FOR WASTEWATER TREATMENT PLANTS
(MEGAWHR/DAY)

	Level 1 A	Level 1 B	Level 1 C	Level 1 D	Level 2 A	Level 2 B	Level 2 C	Level 2 D
PLAN 1								
Major	208	187	210	209	299	269	301	299
Minor	12	34	12	12	14	41	14	14
Non-Urban	2	2	2	2	2	2	2	2
Total	222	223	224	223	315	312	317	315
PLAN 2								
Major	206	174	207	205	295	249	297	295
Minor	15	52	15	15	18	63	18	18
Non-Urban	2	2	2	2	2	2	2	2
Total	223	228	224	222	315	314	317	315
PLAN 3								
Major	206	173	207	204	295	249	297	295
Minor	16	53	16	16	25	88	25	25
Non-Urban	2	2	2	2	5	5	5	5
Total	224	228	225	222	325	342	327	325

TABLE 73

1995 ANNUAL AVERAGE
ELECTRICAL POWER REQUIREMENTS FOR
MAJOR LAND TREATMENT ALTERNATIVES*
(MEGAWHR/DAY)

Plant	Treatment Type: Land	Treatment Type: Level 2		Growth Concept: A	B	C	D
Papillion		X					
Missouri River		X	Total	295	249	297	295
Council Bluffs		X					
Papillion	X						
Missouri River		X	Total	588	464	569	584
Council Bluffs		X					
Papillion	X						
Missouri River	X		Total	813	671	815	817
Council Bluffs		X					
Papillion	X						
Missouri River	X		Total	888	738	889	887
Council Bluffs	X						

*The requirements illustrated in this table are for the various alternatives associated with Plan 3 - Option 2 (Todd Valley).

The electrical requirements for the upsystem treatment and discharge of stormwater are relatively insignificant as compared to the requirement of the wastewater treatment plants and were therefore not quantified. However, the alternatives for the Omaha combined sewer area by Harza Engineers do represent significant power requirements. Table 74 illustrates the electrical demands for the five recommended alternatives.

TABLE 74

ELECTRICAL REQUIREMENTS FOR
OMAHA COMBINED SEWER ALTERNATIVE PLANS

Plan	$/Year*	MEGAWHR/DAY
2	$1,700,000	466
4A	2,000,000	548
4B	1,900,000	521
5A	2,800,000	767
B	3,600,000	986

*Alternative Plans for Abatement of Pollution from Combined Sewer Overflows, Omaha, Nebraska; Harza Engineering Company, October, 1974.

Chemical Requirements - Chemical requirements of the final alternatives are another resource expenditure to be considered in the environmental assessment. These requirements have been estimated for the major, minor, and non-urban wastewater treatment plants and are presented in Tables 75, 76 and 77 for Plans 1, 2, and 3, respectively. These tables show the variations in chemical requirements due to the growth concepts for both Levels I and II treatment in 1995. The chemical considered include alum, lime, sodium carbonate, polymer, ferric chloride, and chlorine. The dosages of these various chemicals were established in the development of the design criteria section of Volume II, Phase I, and are illustrated on the mass balance for each of the treatment plants.

The tables show the increase in chemical requirements due to an increase in treatment from Level I to Level II. This is due to the removal of phosphorous by chemical precipitation. This higher level of treatment, however, does permit a decrease in the ferric chloride requirements for sludge conditioning and also a decrease in chlorine requirements for disinfection.

A slight increase in chemical requirements can also be noted in comparing Plans 1 and 2 due to the distribution of wastewater between the major and minor plants. This is due to the fact that the minor urban plants have a greater dosage chemical requirement than the major urban plants and the limited extension of Plan 2 provides a greater quantity of wastewater to the minor urban plants.

TABLE 75

PLAN 1 CHEMICAL REQUIREMENTS

1995 DAILY AVERAGE IN POUNDS/DAY

Level	Alum as Al^{+3}		Lime as $Ca(OH)_2$		Sodium Carbonate		Polymer		Lime as CaO		Ferric Chloride		Chlorine	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
MAJOR URBAN														
Concept A	0	7,574	0	26,410	0	0	0	526	25,289	31,797	11,804	8,516	8,443	6,332
Concept B	0	6,791	0	24,093	0	0	0	472	22,707	28,522	10,600	7,640	7,570	5,678
Concept C	0	7,578	0	28,116	0	0	0	526	25,428	31,854	11,882	8,538	8,444	6,332
Concept D	0	7,572	0	26,524	0	0	0	527	25,297	31,778	11,783	8,510	8,443	6,333
MINOR URBAN														
Concept A	0	536	0	0	0	1,494	0	24	354	496	204	324	392	288
Concept B	0	1,753	0	0	0	4,884	0	79	1,159	1,621	669	1,061	1,282	943
Concept C	0	536	0	0	0	1,494	0	24	354	496	204	324	392	288
Concept D	0	536	0	0	0	1,494	0	24	354	496	204	324	392	288
NON-URBAN														
All Concepts	0	229	0	0	0	0	0	12	0	0	0	0	185	138
TOTAL														
Concept A	0	8,339	0	26,410	0	1,494	0	562	25,643	32,293	12,008	8,840	9,020	6,758
Concept B	0	8,773	0	24,093	0	4,884	0	551	23,866	30,143	11,269	8,701	9,037	6,759
Concept C	0	8,343	0	28,116	0	1,494	0	562	25,782	32,350	12,086	8,862	9,021	6,758
Concept D	0	8,337	0	26,524	0	1,494	0	563	25,651	32,274	11,987	8,834	9,020	6,759

TABLE 76

PLAN 2 CHEMICAL REQUIREMENTS

1995 DAILY AVERAGE IN POUNDS/DAY

LEVEL	Alum as Al^{+3}		Lime as $Ca(OH)_2$		Sodium Carbonate		Polymer		Lime as CaO		Ferric Chloride		Chlorine	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
MAJOR URBAN														
Concept A	0	7,466	0	26,410	0	0	0	519	24,958	31,353	11,659	8,401	8,322	6,241
Concept B	0	6,213	0	24,093	0	0	0	432	20,924	26,129	10,600	7,640	7,570	5,678
Concept C	0	7,471	0	28,116	0	0	0	518	25,097	31,411	11,737	8,424	8,323	6,242
Concept D	0	7,465	0	26,524	0	0	0	519	24,966	31,404	11,638	8,395	8,322	6,242
MINOR URBAN														
Concept A	0	704	0	0	0	1,963	0	31	466	651	269	426	515	379
Concept B	0	2,703	0	0	0	7,529	0	122	1,787	2,500	1,031	1,636	1,976	1,453
Concept C	0	704	0	0	0	1,963	0	31	466	651	269	426	515	379
Concept D	0	704	0	0	0	1,963	0	31	466	651	269	426	515	379
NON-URBAN														
All Concepts	0	229	0	0	0	0	0	12	0	0	0	0	185	138
TOTAL														
Concept A	0	8,399	0	26,410	0	1,963	0	562	25,424	32,004	11,928	8,827	9,022	6,758
Concept B	0	9,145	0	24,093	0	7,529	0	566	22,711	28,629	11,631	9,276	9,546	7,131
Concept C	0	8,404	0	28,116	0	1,963	0	561	25,563	32,062	12,006	8,850	9,023	6,759
Concept D	0	8,398	0	26,524	0	1,963	0	562	25,432	32,055	11,907	8,821	9,022	6,759

TABLE 77

PLAN 3 CHEMICAL REQUIREMENTS

1995 DAILY AVERAGE IN POUNDS/DAY

LEVEL	Alum as Al^{+3} I	Alum as Al^{+3} II	Lime as $Ca(OH)_2$ I	Lime as $Ca(OH)_2$ II	Sodium Carbonate I	Sodium Carbonate II	Polymer I	Polymer II	Lime as CaO I	Lime as CaO II	Ferric Chloride I	Ferric Chloride II	Chlorine I	Chlorine II
MAJOR URBAN														
Concept A	0	7,456	0	26,410	0	0	0	518	24,927	31,311	11,645	8,391	8,311	6,233
Concept B	0	6,175	0	24,093	0	0	0	429	20,809	25,975	9,769	6,982	6,877	5,158
Concept C	0	7,457	0	28,116	0	0	0	517	25,053	31,422	11,718	8,408	8,307	6,230
Concept D	0	7,455	0	26,524	0	0	0	519	24,935	31,292	11,625	8,384	8,311	6,233
MINOR URBAN														
Concept A	0	0	0	0	0	0	0	0	476	476	275	275	527	527
Concept B	0	0	0	0	0	0	0	0	1,798	1,798	1,038	1,038	1,989	1,989
Concept C	0	0	0	0	0	0	0	0	476	476	275	275	527	527
Concept D	0	0	0	0	0	0	0	0	476	476	275	275	527	527
NON-URBAN														
All Concepts	0	0	0	0	0	0	0	0	0	0	0	0	185	185
TOTAL														
Concept A	0	7,456	0	26,410	0	0	0	518	25,403	31,787	11,920	8,666	9,023	6,945
Concept B	0	6,175	0	24,093	0	0	0	429	22,607	27,773	10,807	8,020	9,051	7,332
Concept C	0	7,457	0	28,116	0	0	0	517	25,529	31,898	11,993	8,683	9,019	6,942
Concept D	0	7,455	0	26,526	0	0	0	519	25,411	31,768	11,900	8,659	9,023	6,945

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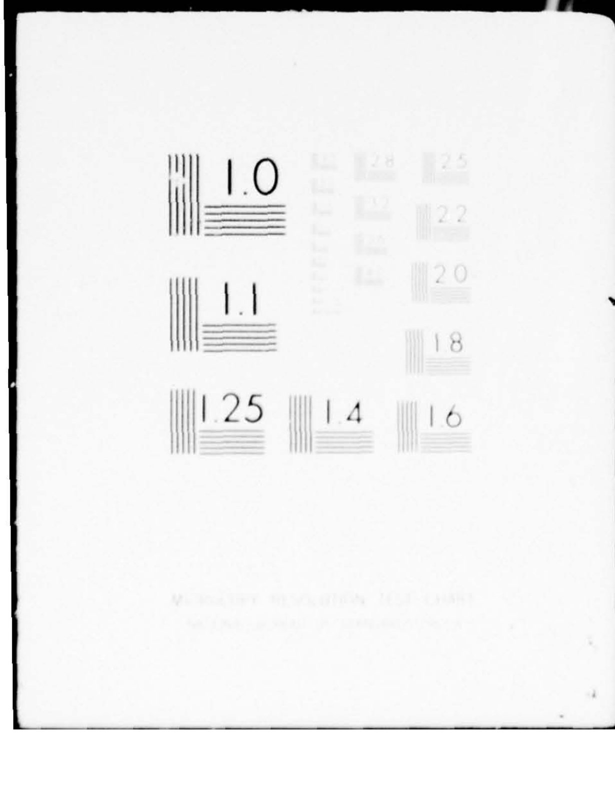


The effects of the various land treatment options can be illustrated by a review of Plan 3 of Table 77. This table assumes Level 2 treatment of the major urban plants. If the major urban plants were to be transported to land treatment, the Level 1 requirements would be used instead of Level 2 resulting in a significant reduction in chemical requirements.

LEGEND

PLANT	MAJOR URBAN	MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL	T	T
SECONDARY TREATMENT PRIOR TO LAND APPLICATION	S	S

STORMWATER

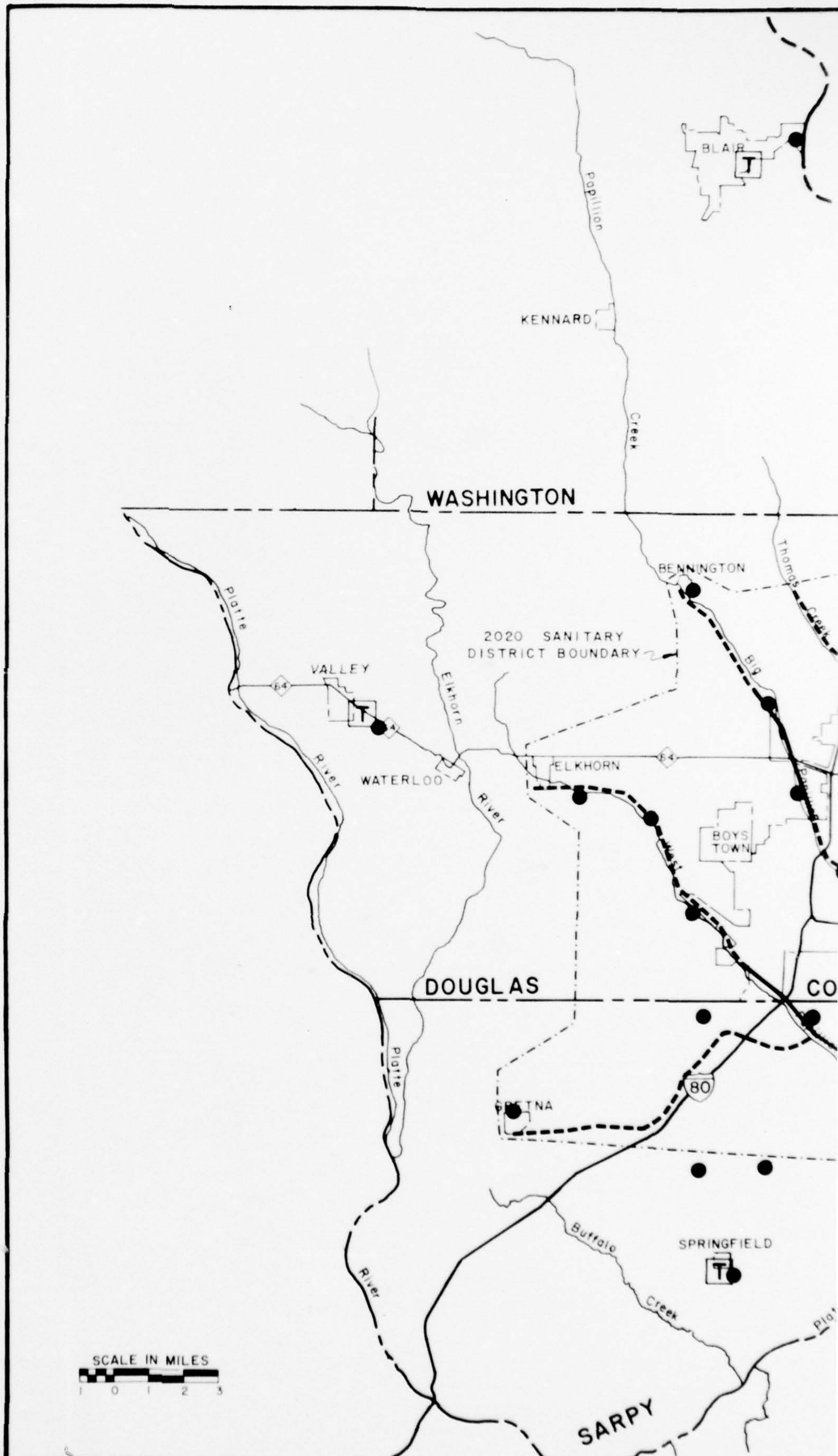
SEPARATE BASINS ●

COMBINED BASINS ○

TRANSMISSION FACILITIES

EXISTING ———

PROPOSED - - - - -



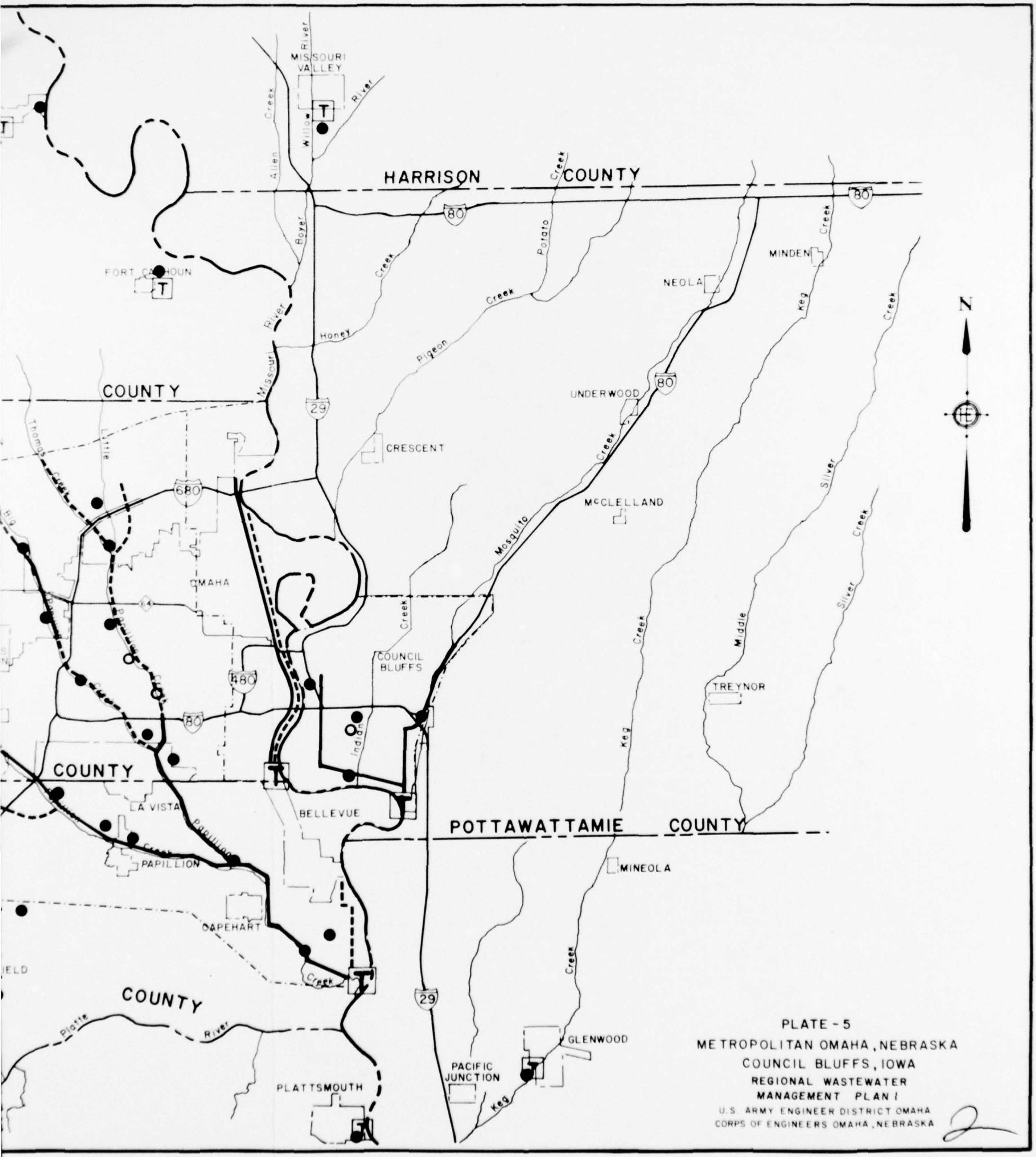
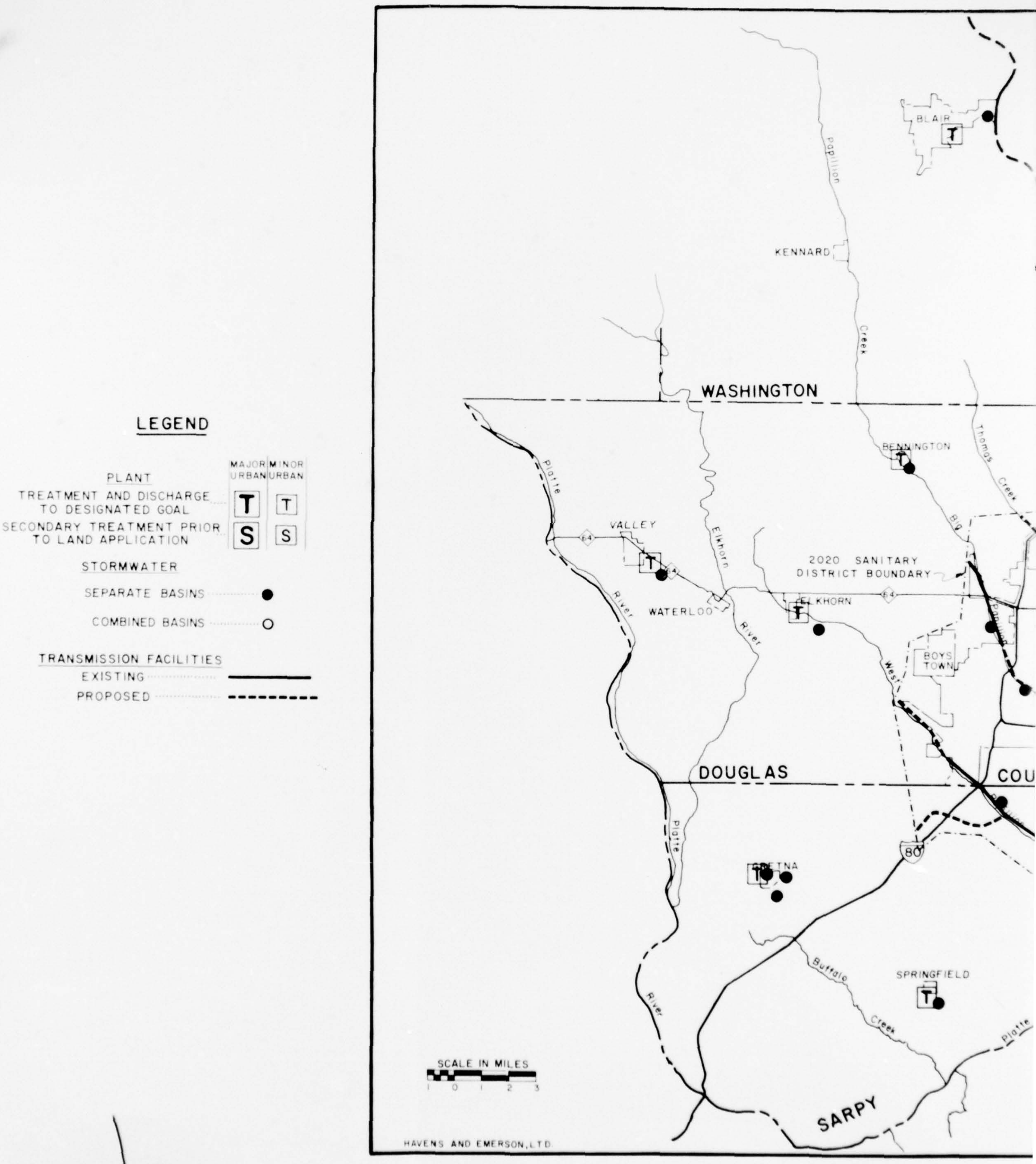


PLATE - 5

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER MANAGEMENT PLAN I
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA


LEGEND
PLANT
MAJOR URBAN
MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
T
SECONDARY TREATMENT PRIOR TO LAND APPLICATION
S
STORMWATER
SEPARATE BASINS
COMBINED BASINS
TRANSMISSION FACILITIES
EXISTING
PROPOSED
SCALE IN MILES
1 0 1 2 3
HAVENS AND EMERSON, LTD.
WASHINGTON
DOUGLAS
SARPY
COU
BLAIR
KENNARD
Papillion
Creek
BENNINGTON
Thomas Creek
Big
VALLEY
WATERLOO
ELKHORN
Elkhorn
River
Platte
River
2020 SANITARY DISTRICT BOUNDARY
BOYS TOWN
West
GRETNA
80
SPRINGFIELD
Buffalo
Creek
Platte
64

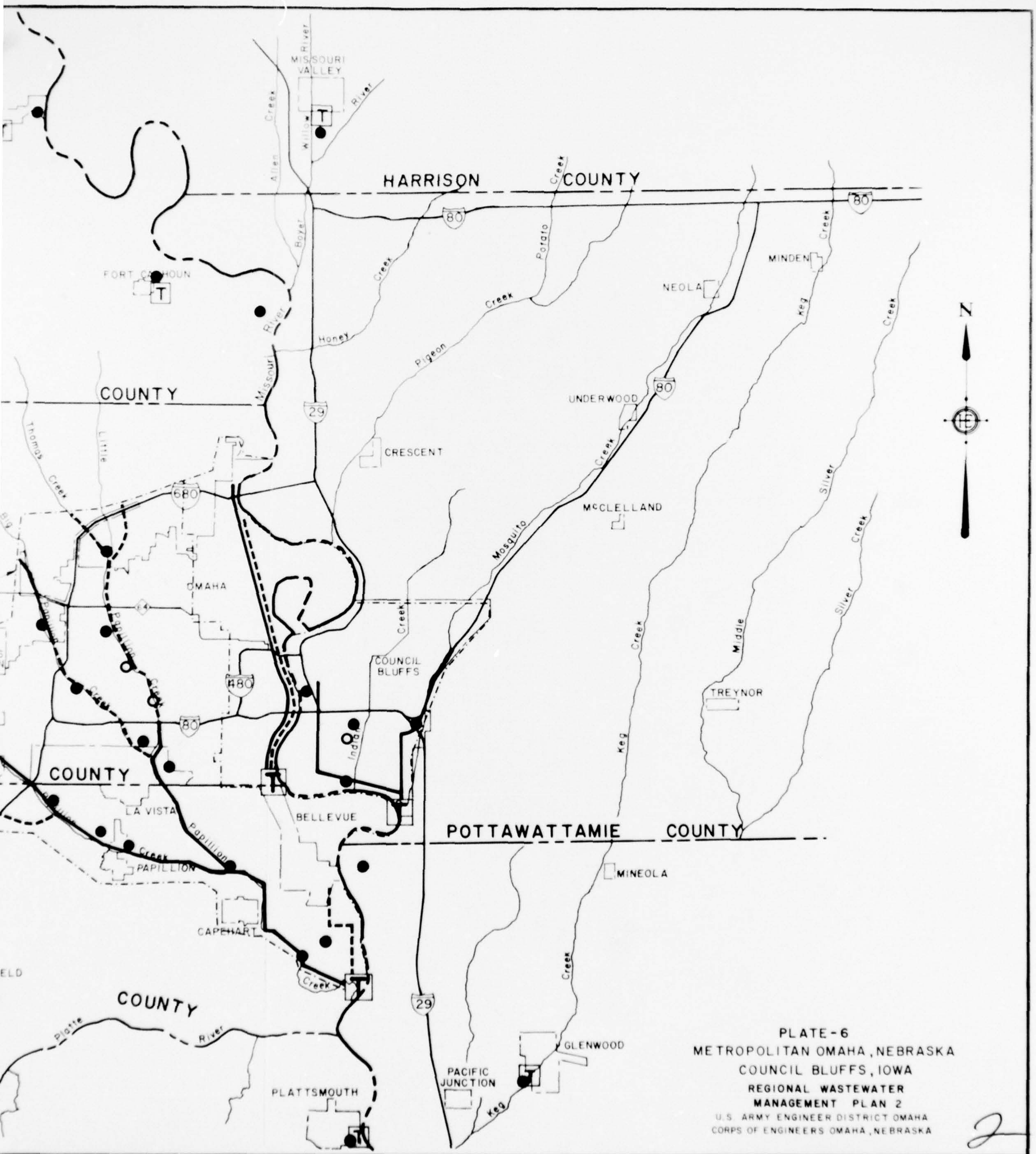
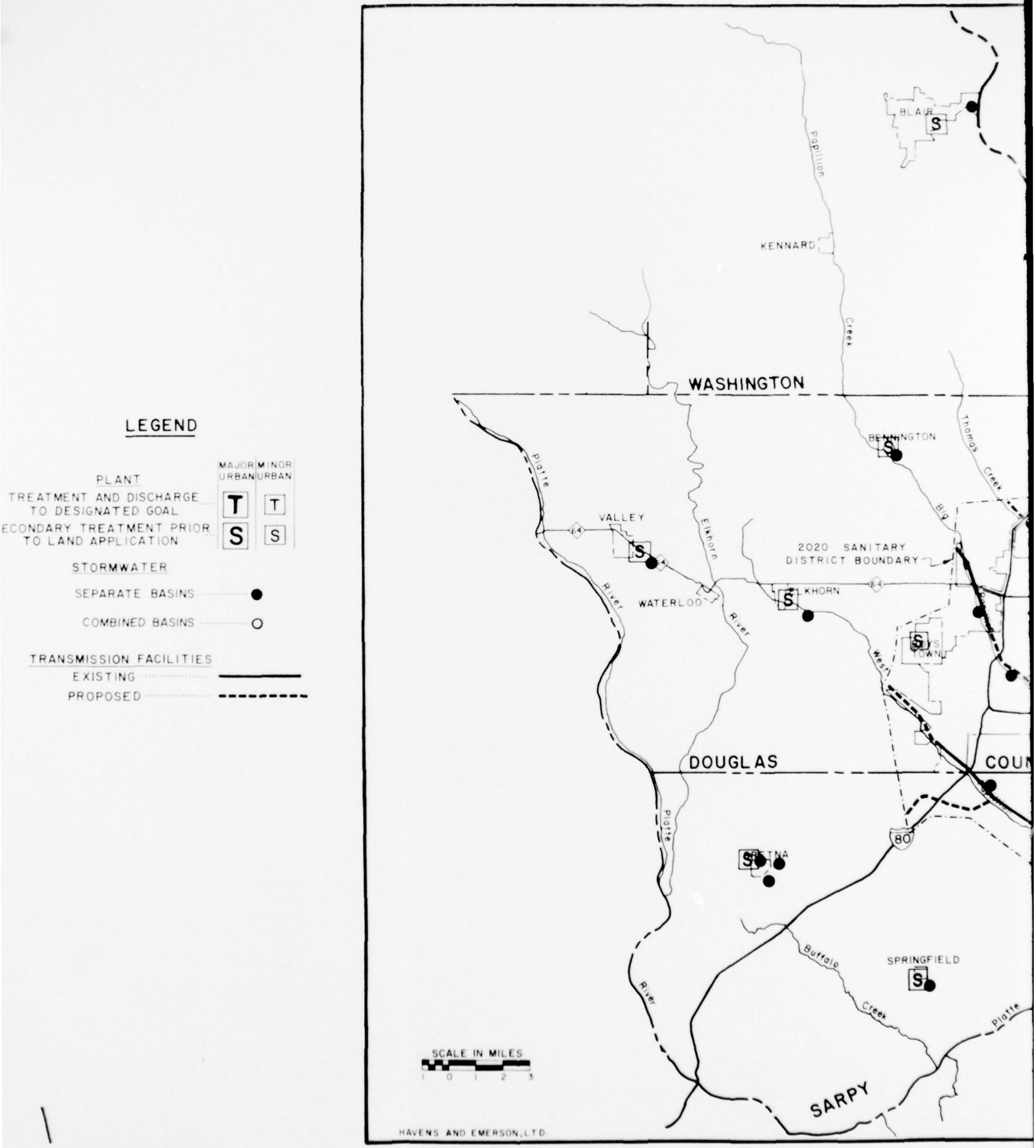


PLATE-6
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN 2
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA



LEGEND
PLANT
MAJOR URBAN
MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
T
T
ECONDARY TREATMENT PRIOR TO LAND APPLICATION
S
S
STORMWATER
SEPARATE BASINS
COMBINED BASINS
TRANSMISSION FACILITIES
EXISTING
PROPOSED
BLAIR
Papillion
KENNARD
Creek
WASHINGTON
BENNINGTON
Thomas
Creek
Big
Platte
VALLEY
64
Elkhorn
2020 SANITARY DISTRICT BOUNDARY
ELKHORN
WATERLOO
River
River
West
DOUGLAS
COUN
Platte
80
River
Buffalo
Creek
SPRINGFIELD
Platte
SCALE IN MILES
1 0 1 2 3
SARPY
HAVENS AND EMERSON, LTD.

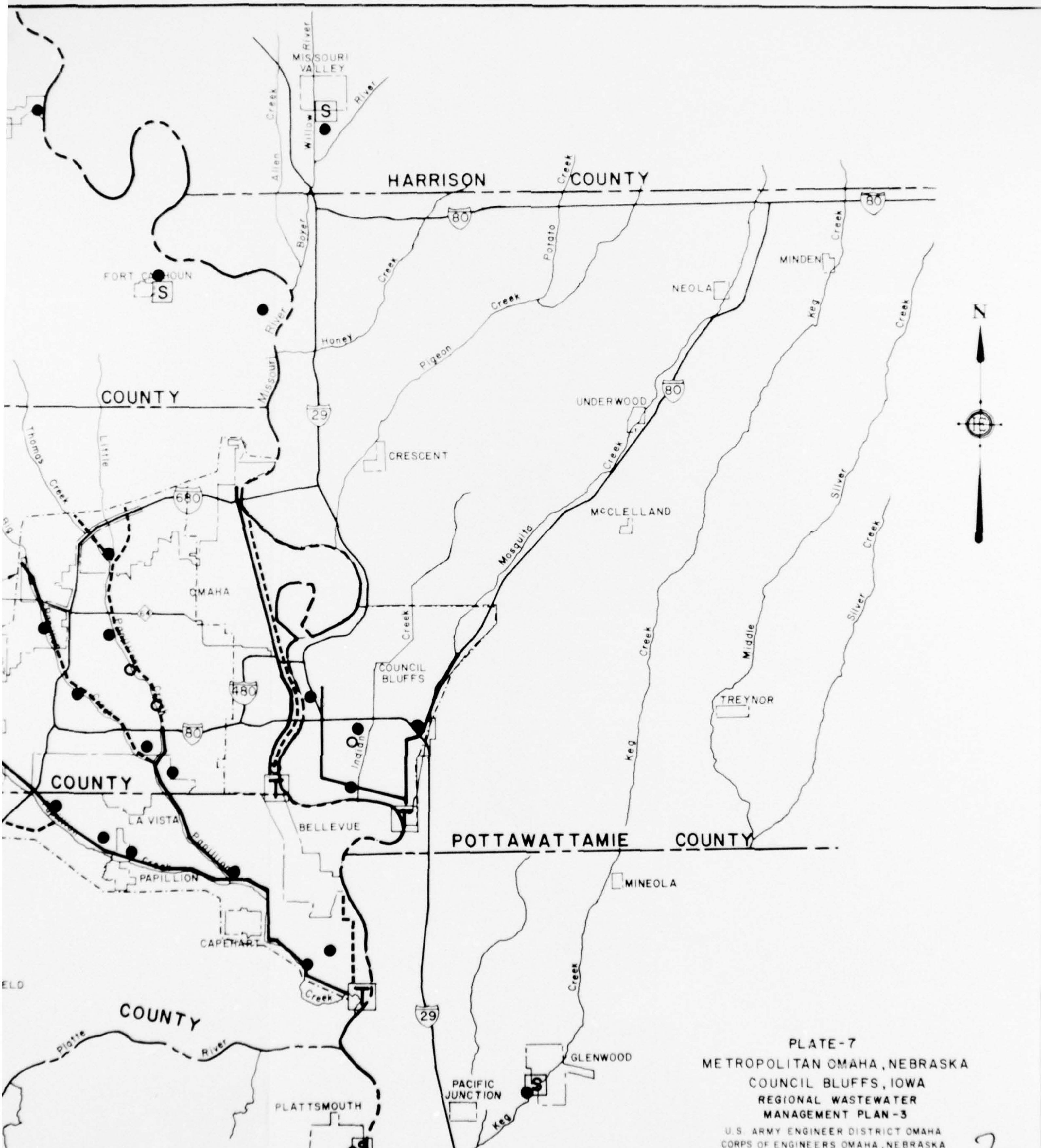


PLATE-7
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN-3
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

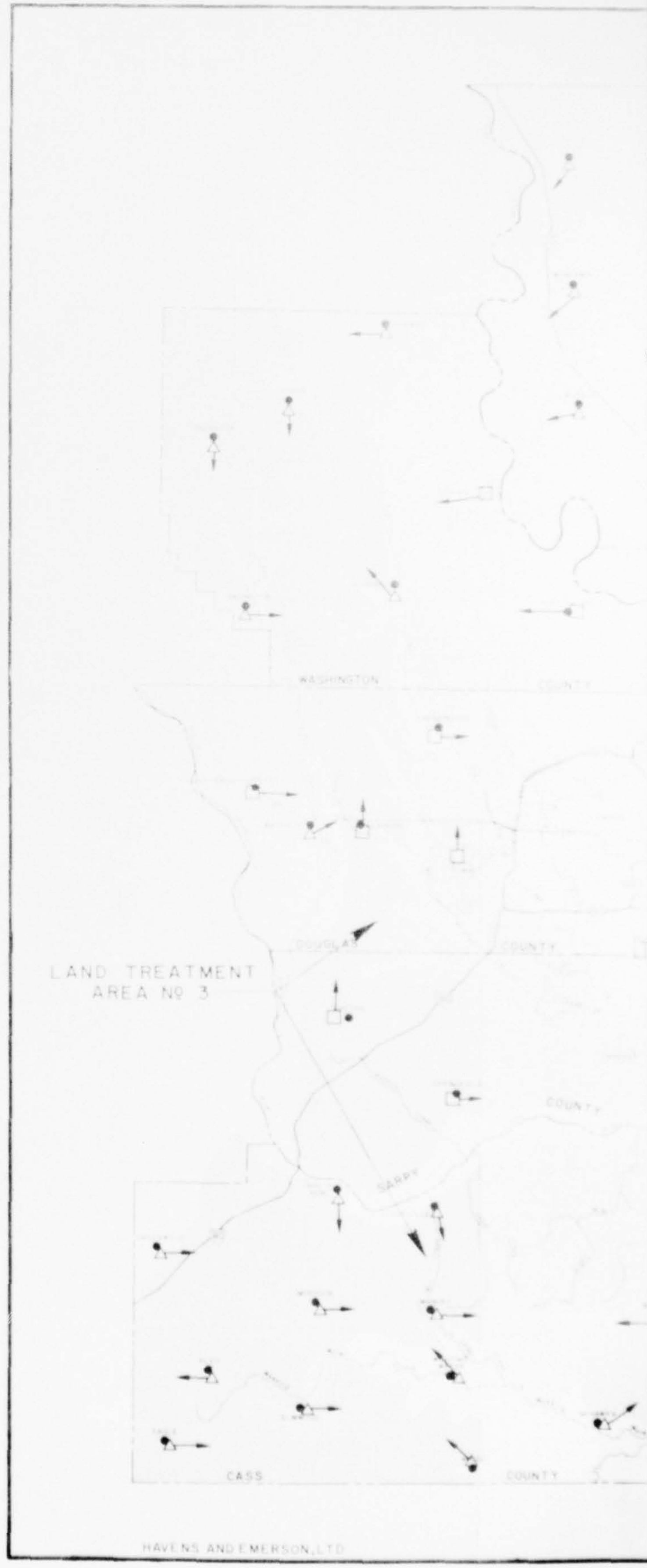
2

LEGEND

□ MINOR URBAN WASTEWATER TREATMENT PLANTS

[T] MAJOR URBAN WASTEWATER TREATMENT PLANTS

△ NON URBAN WASTEWATER TREATMET PLANTS



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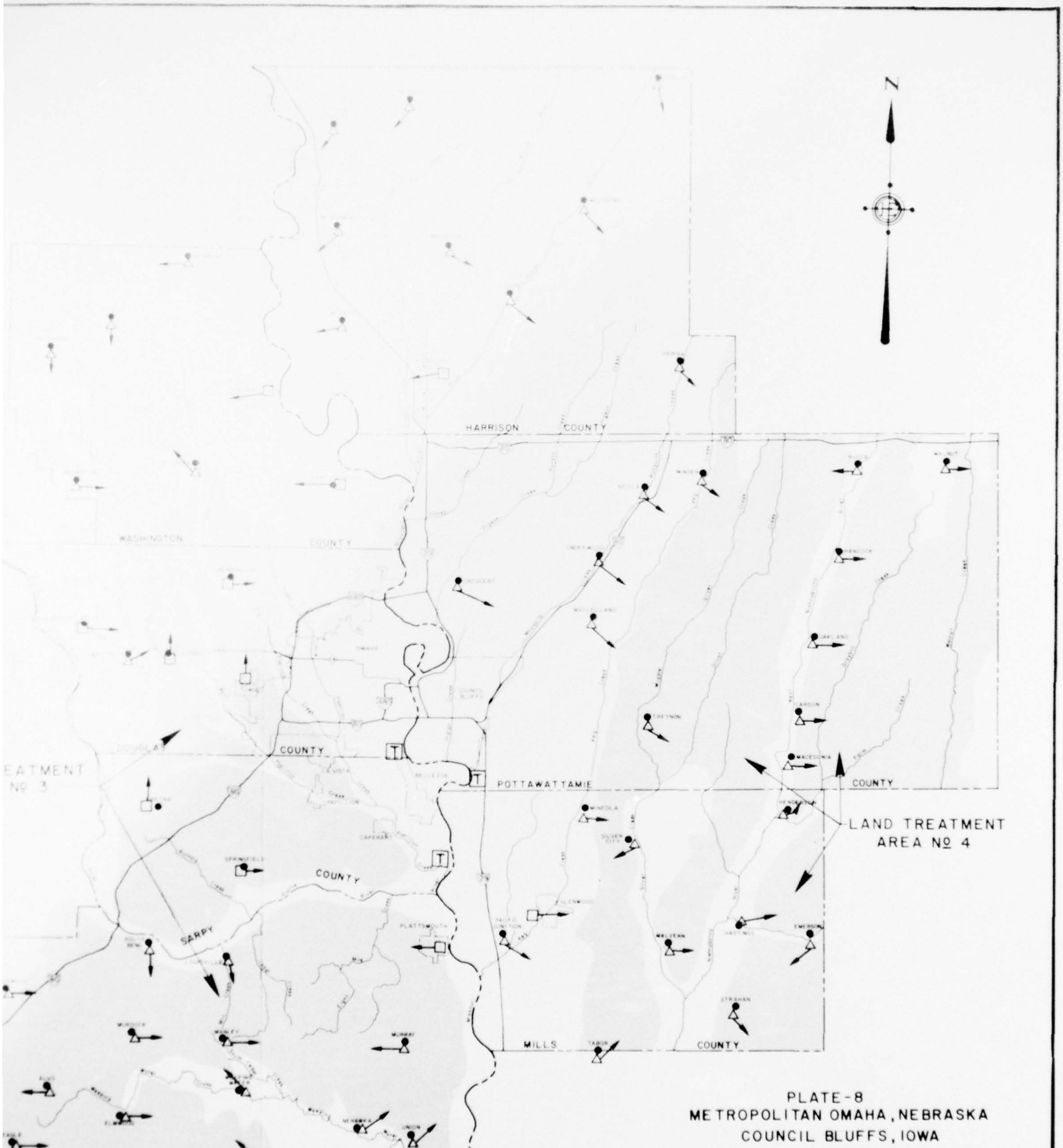


PLATE-8
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

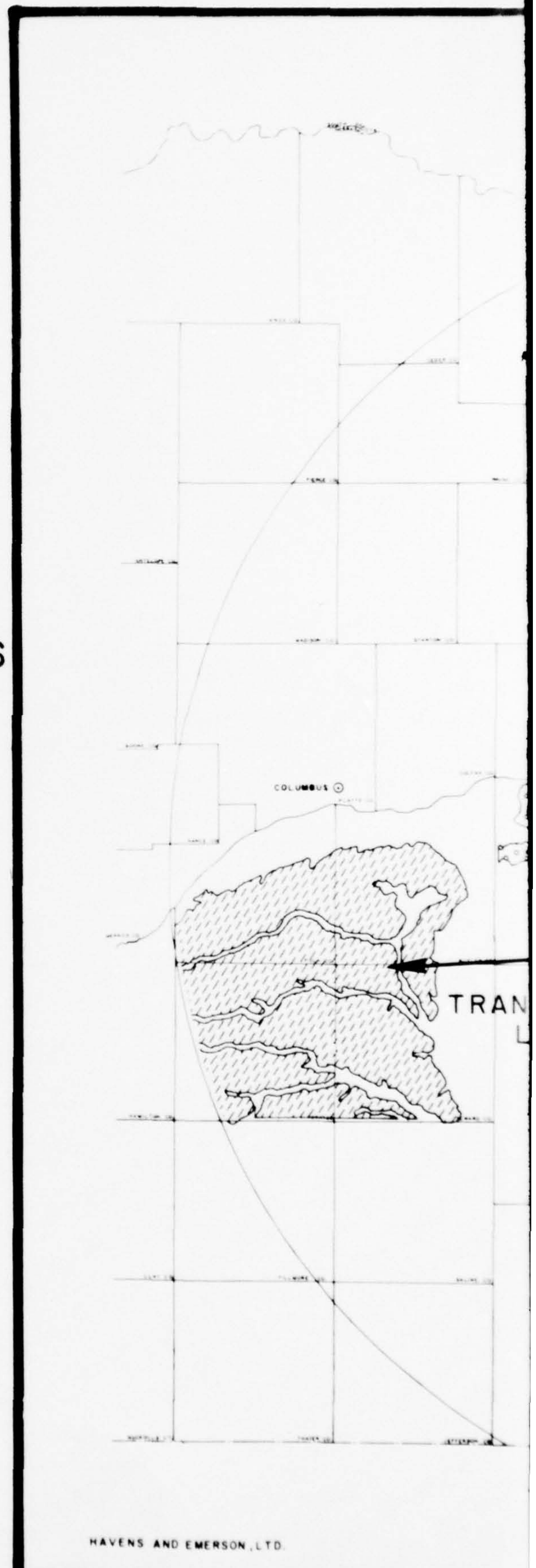
PLAN 3
LAND TREATMENT AREAS
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

AVENS AND EMERSON, LTD.

LEGEND

LAND TREATMENT PRIORITY OF SITES

- №1 23 AND 22 - Nebraska
- №2 29 AND 30 - Nebraska
- №3 21, 22 AND 26 - Nebraska
- №4 26 AND 29 - Iowa
- №5 6 AND 14 - Iowa
- №6 12, 18, 33 AND 34 - Iowa



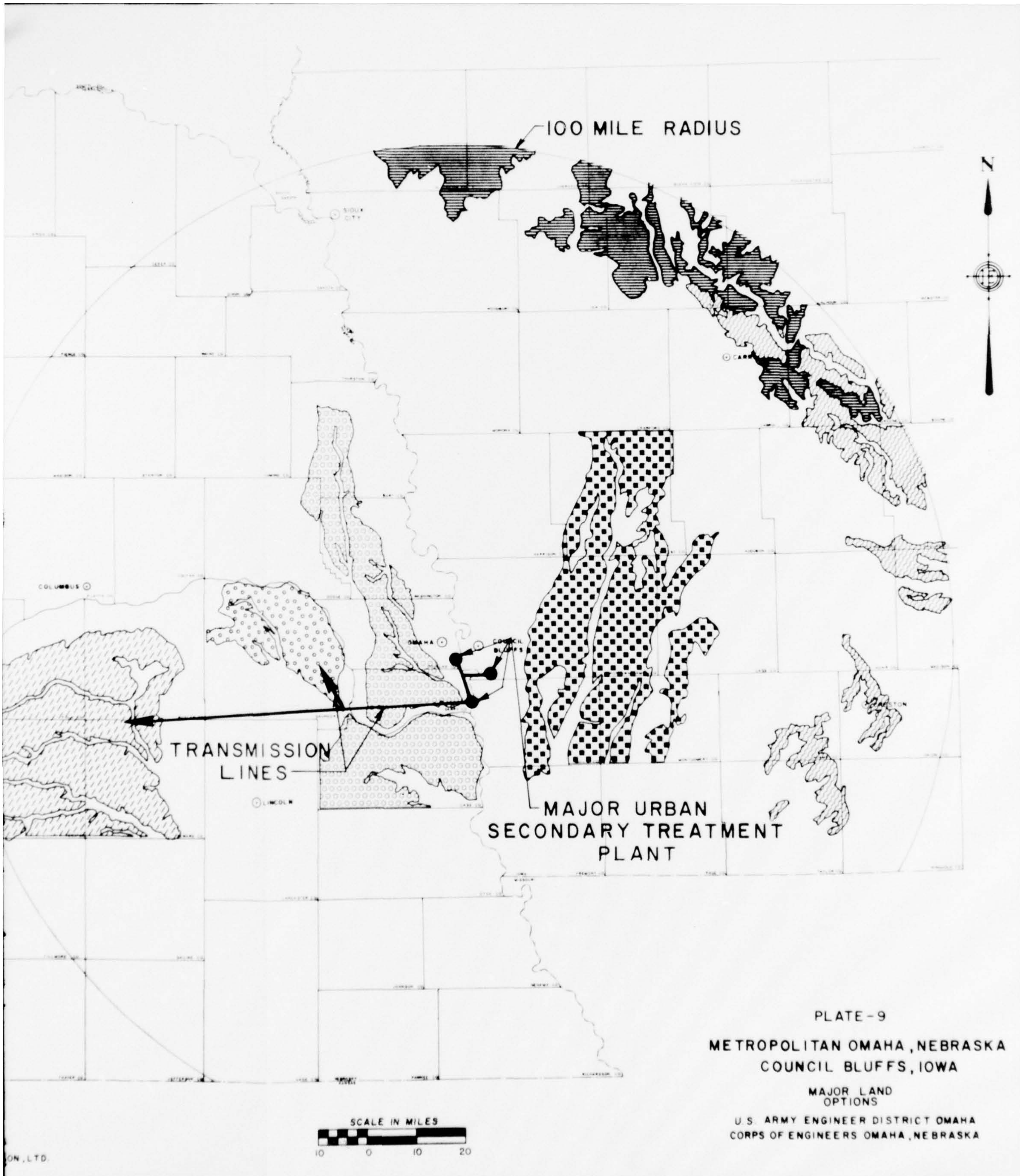


PLATE-9

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

MAJOR LAND OPTIONS

U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

E. SPECIFIC PLANNING CONSIDERATIONS

During the progress of this Wastewater Management Study, several items were investigated which directly affect the alternative plans and the continuous planning process. This section presents the results of our analysis on the following topics:

- Omaha Combined Sewer Overflows
- Water Treatment Plant Wastes
- Demonstration of Land Treatment
- Industrial Concerns
- Water Conservation Practices
- Papillion Reservoirs

OMAHA COMBINED SEWER OVERFLOWS

One of the serious water pollution problems of the Urban Study area results from the combined sewer overflow of the Omaha-Missouri River Sewerage System. Recognizing the importance of this problem, the Omaha District authorized Harza Engineering Company to complete a study of Alternative Plans for Abatement of Pollution from Combined Sewer Overflows[9]. The study defined the extent of the problems and investigated several alternative approaches for various treatment levels and design storms.

Five conveyance and storage alternatives were further refined and costed, and also analyzed for socio-environmental considerations. One of these alternatives was incorporated into this wastewater management study as an integral component of the plans presented.

The Harza alternative and the multiple discharge alternative developed in Phase I were evaluated for DO effect on the River by use of the computer model. The combination of treatment levels and handling technique were analyzed and reported in Section C of this report. The analysis indicates that under historic low-flow situations the multiple discharge approach will meet the DO standards using the wastewater effluent equivalent to Level 1 and stormwater effluent equivalent to Level 2. Future planning which provides upstream diversions and lower River flows will produce a situation requiring higher treatment levels. Representative costs for the various levels of stormwater treatment are shown in Table 78.

The conveyance and storage approach developed in the Harza study provides a small continuous discharge from the Missouri River Treatment Plant which produces a negligible effect on the DO of the

TABLE 78

UPSYSTEM STORAGE AND TREATMENT
OMAHA COMBINED SEWER AREA
CAPITAL COST COMPARISON
($ MILLION)

Design Storm	STORMWATER TREATMENT LEVEL 1	2	3*
1 year	224	263	395
5 year	364	425	630
10 year	427	501	743

*A higher level of stormwater treatment not previously discussed in the Phase I Report. Cost based on Cleveland-Akron Area Survey Scope Study, Buffalo District, COE.

stream using an effluent quality equivalent to the stormwater Level 1.

<u>Planning Recommendations</u>

Further questions arise from the conclusions of the water quality modeling. These questions should be addressed as part of the continuous planning process and include:

Should the short term effects of a storm adhere to the same water quality standards as wastewater discharges?

Should storm inputs correspond to the critical low flow of the stream or can a statistical approach be used to determine the relationship between River stage and storm event?

Should combined sewer overflows be limited to one per year or could a higher number be accepted?

What is the quality of the overflows during various storm sizes and what is the water quality effect on the River?

The following actions are recommended to develop the answers to the above questions which will provide data required to refine the model inputs and the alternatives to develop the most cost effective solution to the combined overflows.

1. Develop a frequency curve to establish the recurrence interval associated with the flow conditions of the Missouri River and design storm occurrences.

2. Develop a monitoring and surveillance program to:

   a. Determine quality of the combined sewer overflow during storm occurrences.

   b. Determine water quality parameters of the Missouri River upstream of Omaha during storm occurrences.

Immediate Improvements

The following discussion briefly describes problems and recommended improvements associated with the Omaha interceptor system which can be implemented while planning efforts are being conducted on the pollution abatement program.

The Omaha Interceptor parallels the Missouri River from Bridge Street in North Omaha to the Missouri River treatment plant and is designed to convey sanitary wastewater and combined sewage from a service area of approximately 29,000 acres. In general, diversion structures are located near the outfalls of each sewer subsystem which direct dry weather flow and a limited amount of wet weather flow to grit removal facilities and/or lift stations prior to entering the interceptor system.

Difficulties have been encountered in the maintenance and operation of the diversion structures, grit removal facilities, and pump stations, which have resulted in considerable discharge of untreated wastewater to the Missouri River. The basic problem is that the facilities are overloaded in respect to flow and grit. Field observation[10] noted the following problems which need to be overcome and/or improved in order to provide a safer and more efficient interceptor system; inadequate system/equipment design,

grit overload, hydraulic overload, deep structures, moisture/ corrosion, odor, and multiple site locations.

Previous reports[2,11] have also analyzed the problems of the interceptor system and recommended construction improvements; some of which have been acted upon. To increase the reliability and performance of this system, provisions are required at all of the existing grit removal and pumping facilities along the interceptor to prevent, primarily with the addition of duplicate grit facilities, dry-weather wastewater flow to the river during periods of repair or routine maintenance. The Leavenworth and Burt/Izard Lift Stations have caused the greatest difficulties and therefore appear to be the highest priority. Table 79 summarizes the project cost range for improvements to the stations listed to prevent dry-weather bypasses.

TABLE 79

GRIT REMOVAL AND LIFT STATION IMPROVEMENTS

Station	Project Cost Range
Leavenworth	\$1,000,000 to \$1,500,000
Burt/Izard	\$1,000,000 to \$1,500,000
Bridge St., Pierce St., Hickory St., Riverview Park, Missouri Avenue, Quaker Oats	\$1,300,000 to \$1,500,000

Conclusions

Immediate improvements to the Omaha Interceptor are needed to prevent unnecessary discharges of raw wastewater to the Missouri River. A conveyance and storage approach to overflow treatment of the one-year storm appears most cost-effective based on the criteria used in the study. However, the rational behind some of the criteria (design storm, future Missouri River flow, etc.) should be reanalyzed and used for future planning efforts.

WATER TREATMENT PLANT WASTES

The chemical processes used for water supply treatment produce wastes which are primarily inorganic and come from the sedimentation and filter backwash operation. The following discussion concerns the possible disposal of these wastes at existing municipal wastewater treatment plants using Council Bluffs as a case study.

General Description

The numerous alternatives available for disposal of water plant wastes can be grouped into two broad categories: (1) on-site treatment of wastes with off-site ultimate disposal, and (2) transport to a remote or regional site for treatment and ultimate disposal. The principle variables include the following:

1. Type of treatment
   (Thickener, vacuum filter, lagoons, existing wastewater treatment plant, etc.)

2. Ultimate Disposal Technique
   (Incineration, landfill, land application, etc.)

3. Transport Mode
   (Truck, force main, existing sewer, etc.)

The initial approach to this problem is a preliminary scan of the potential alternatives, in consideration of local constraints, which will result in a list of feasible alternatives to be seriously considered. A detailed study is then required prior to selection and implementation of a recommended plan.

A detailed study was not intended here but rather investigation of one particular aspect of this problem which is the effect of water plant wastes on the design and operation of wastewater

treatment plants.

Alternative Costs

For this analysis, two alternatives were designed and costed for Council Bluffs.

Alternative 1 - The water plant wastes are mixed with the residential and industrial wastes in the influent sewer and treated at the wastewater treatment plant, to wastewater Levels 1 and 2.

Alternative 2 - The water plant wastes are treated separately by dewatering and landfill as proposed in the Henningson, Durham, and Richardson report[12]. The wastewater treatment plant is designed to produce the quality related to wastewater Levels 1 and 2 for the residential and industrial wastewater only. Table 80 illustrates the capital and O & M costs for these alternatives and their differences.

The capital and O & M costs for the combined treatment are more expensive than incurred for separate systems in Level 1. The reason for this is due primarily to the increased costs of sludge handling. The resulting mixture of the inorganic water plant wastes and the organic wastewater sludges is treated as wastewater sludge in the combined approach. In the separate approach, the inorganic sludges are treated and disposed of by a lower cost method due to the reduced amount of organic material.

At treatment Level 2, the combined system becomes more viable. Two factors affect the costs in this situation: sludge and nitrification. The increase due to inorganic wastes from the water plant is masked by the higher levels of inorganic wastes

TABLE 80

WATER PLANT WASTE CONTROL COSTS
COUNCIL BLUFFS

	Level 1		Level 2	
	Capital* ($1000)	O & M.** ($1000/Yr)	Capital* ($1000)	O & M.** ($1000/Yr)
Alternative 1				
Wastewater Plant, only	8,695	1,025	9,054	1,363
Alternative 2				
Wastewater Plant	6,865	751	8,066	1,127
Water Plant	1,165	122	1,165	122
Alt. 2 - Total	8,080	873	9,231	1,249
Difference (Alt. 1 - Alt. 2)	665	152	-177	114

* 1977 Capital Expenditures to satisfy specified Level of treatment and 1995 projected loads.

** 1995 Annual Operation and Maintenance Cost based on projected 1995 loads.

produced by chemical treatment in Level 2. Requirements for nitrification are reduced because of the increased solids removed due to the water plant wastes. The net result of these factors is a lower capital expense and an increased O & M expense for the combined approach.

The analysis shows that for Level 1 wastewater treatment, which meets water quality standards, the water plant waste generally should be treated separately at the water treatment plant. If Level 2 treatment of wastewater is required the combination of water plant wastes with the wastewater becomes more viable and should be considered on a site specific study. The numerous smaller plants should also be studied individually where sludges are land filled or spread on agricultural land rather than incinerated and where Level 2 treatment may be required by water quality consideration.

Another potential alternative which has not been designed or costed for Council Bluffs would provide for separate treatment of the water plant wastes at the wastewater treatment plant. This would require separate transmission lines to the wastewater treatment plant but there are benefits to be considered. The availability of a fraction of the water plant sludges to mix with the wastewater plant sludges can improve filterability and reduce chemical conditioning requirements without overextending the sludge treatment facilities. A portion of this sludge can also be used to enhance sedimentation in the primary settling tanks. The centralization of sludge handling at one location versus two

locations would reduce equipment and personnel requirements and the dewatered water plant wastes could be hauled to landfill and not treated to the levels required by organic sludges. In the case of Council Bluffs, the desirability of this alternative is reduced by the extreme distance (over 9 miles) between the facilities. However, in Bellevue, where locations of the water plant and wastewater plant are closer, this concept was favorably considered[13].

Apparently, the City of Council Bluffs is considering discharge of some water plant lime sludges into the sewer system in an attempt to reduce existing sewer odor problems. A demonstration project of this nature should be designed not only to address the odor problem but should evaluate the impact of this sludge on the operation and performance of the wastewater treatment plant. Solids deposition and build-up in the sewer system also deserves serious consideration in evaluation of the demonstration project.

Conclusions

With Level 1 wastewater treatment requirements, the analysis shows that separate treatment of water plant wastes is less costly than mixing the waste with the wastewater plant influent. At Level 2 wastewater requirements, mixing of the waste sources becomes more viable and would require specific analysis for a particular combination of water and wastewater treatment plant.

Using a portion of the water treatment plant wastes in the wastewater treatment plant, it should be analyzed with specific

combinations of water and wastewater treatment plants. The proposed demonstration of water plant waste for odor control in Council Bluffs should be expanded to include the analysis of the effect on the wastewater treatment processes.

DEMONSTRATION OF LAND TREATMENT

Land treatment technology is used in this study as a method of wastewater management. This approach is practiced in various forms throughout the country, but very little detailed analysis has been performed. Specific information is required to determine the effect of land treatment under conditions in the Omaha area including: climatology, soil type, and preferred crop.

The following preliminary proposal is presented to show the general outlines of a demonstration project to determine the effect of such treatment in the Omaha area. The project is proposed for a site associated with Boys Town wastewater treatment plant and totally within Boys Town property. As a demonstration facility, only a portion of the Boys Town effluent would be used for land treatment. The remaining flow would be discharged to Hell's Creek which is the current practice. Monitoring equipment is proposed to determine the effectiveness of land treatment as a disposal method and the effect on crop yield and farm management would be evaluated. Federal funding for such a research project is possible after the development of a final proposal consisting of costs and operation, maintenance, monitoring and evaluation methodologies.

The following preliminary proposal and capital costs were developed for Havens and Emerson, Ltd. by John W. Addink, Ph.D., PE; Ronald J. Gaddis, MS; and Leonard L. Bashford, Ph.D., PE. (Agricultural Engineers for Lincoln, Nebraska).

Preliminary Proposal

Layout - Figure 19 shows the proposed layout. The effluent from Boys Town wastewater treatment plant would be taken from an existing pipeline east of the lake to a holding pond. The effluent would be pumped from the pond, west approximately one-quarter mile through a pipeline under 144th Street to a center-pivot irrigation rig.

The center-pivot would be 900 feet long, covering approximately 60 acres. Slopes under the pivot range from approximately 2 to 15%. Soils are deep, well-drained, moderately fine-textured on loess uplands. This seems to be a good demonstration site.

Capacity - The Boys Town treatment plant discharge ranges from 100 to 300 gpm each day and averages approximately 200 gpm according to Boys Town personnel. The Omaha-Council Bluffs study suggests maximum application amounts of 6 inches per month or 0.2 inches per day. Approximately 60 acres will handle 200 gpm at 0.2 inches per day without a large storage reservoir.

Allowing for some downtime and other non-irrigation time, a 300 gpm pivot system is recommended.

Storage - A holding pond capacity of one to two days pumping requirements would be adequate to demonstrate effluent irrigation under these climatic, crop and soil conditions.

Drainage - The water table is 150 to 200 feet below the ground surface in this area. Saturated-soil conditions should not develop above this level unless a restrictive layer is encountered.

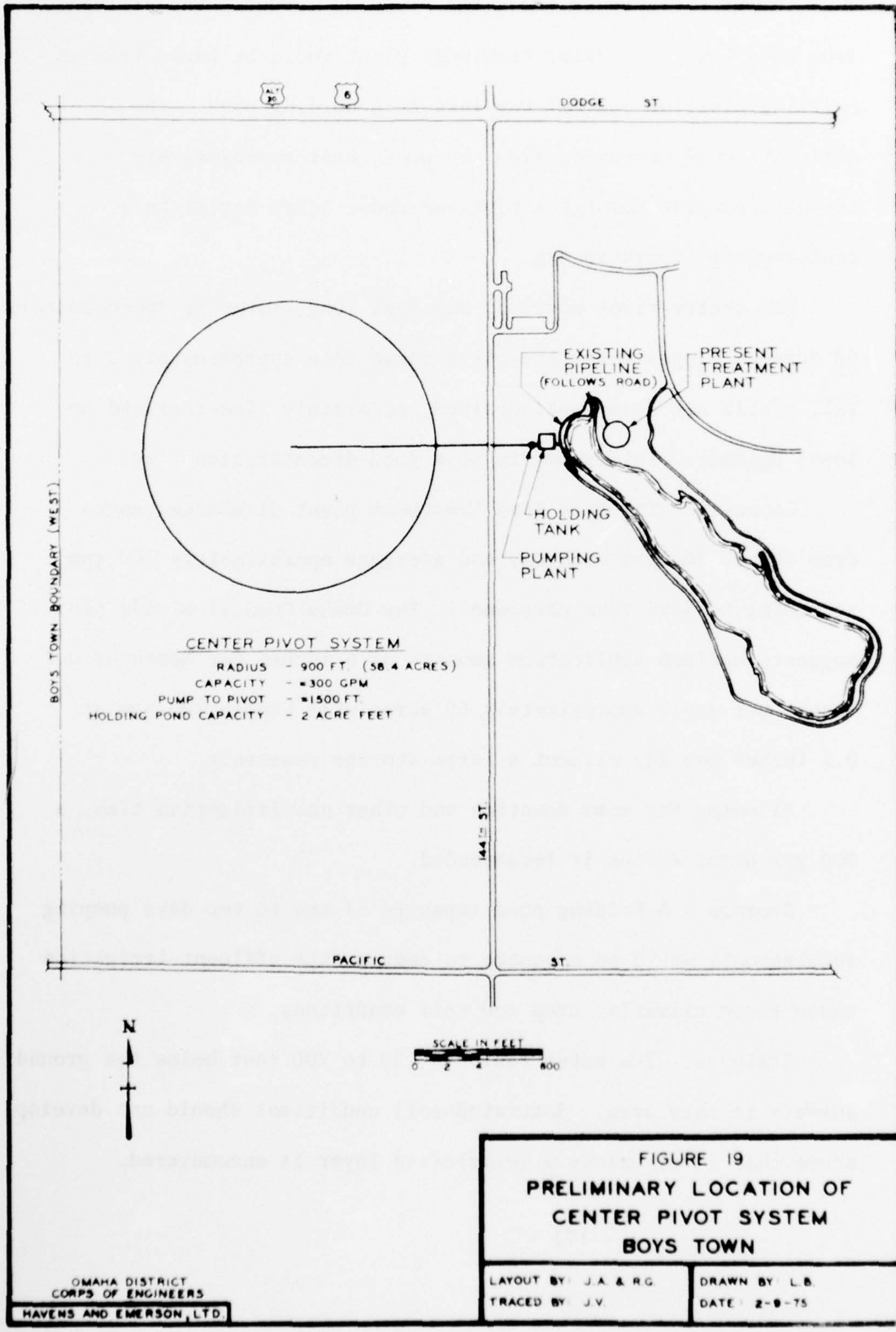


FIGURE 19

PRELIMINARY LOCATION OF CENTER PIVOT SYSTEM BOYS TOWN

Tile drainage is not recommended at this time unless a closer examination reveals a restrictive layer close to the surface.

Monitoring - Since a completely saturated condition may not develop close to the surface, tile drains would not be effective in collecting treated wastewater for analysis. Water movement downward to the water table 150 to 200 feet below the surface may take considerable time. Therefore, monitoring of nutrient movement through the soil profile may be required under unsaturated conditions.

Vacuum extractors (Figure 20) could be used to collect solid moisture samples under these conditions. Rate of soil water and nutrient movement can be estimated by use of these devices.

Costs - Preliminary installation costs of the system are shown in Table 81. Additional field and design work would need to be performed for closer estimates. No estimates are presented for operation and maintenance of the total project including sampling and evaluation of the impacts on wastewater renovation and crop yield.

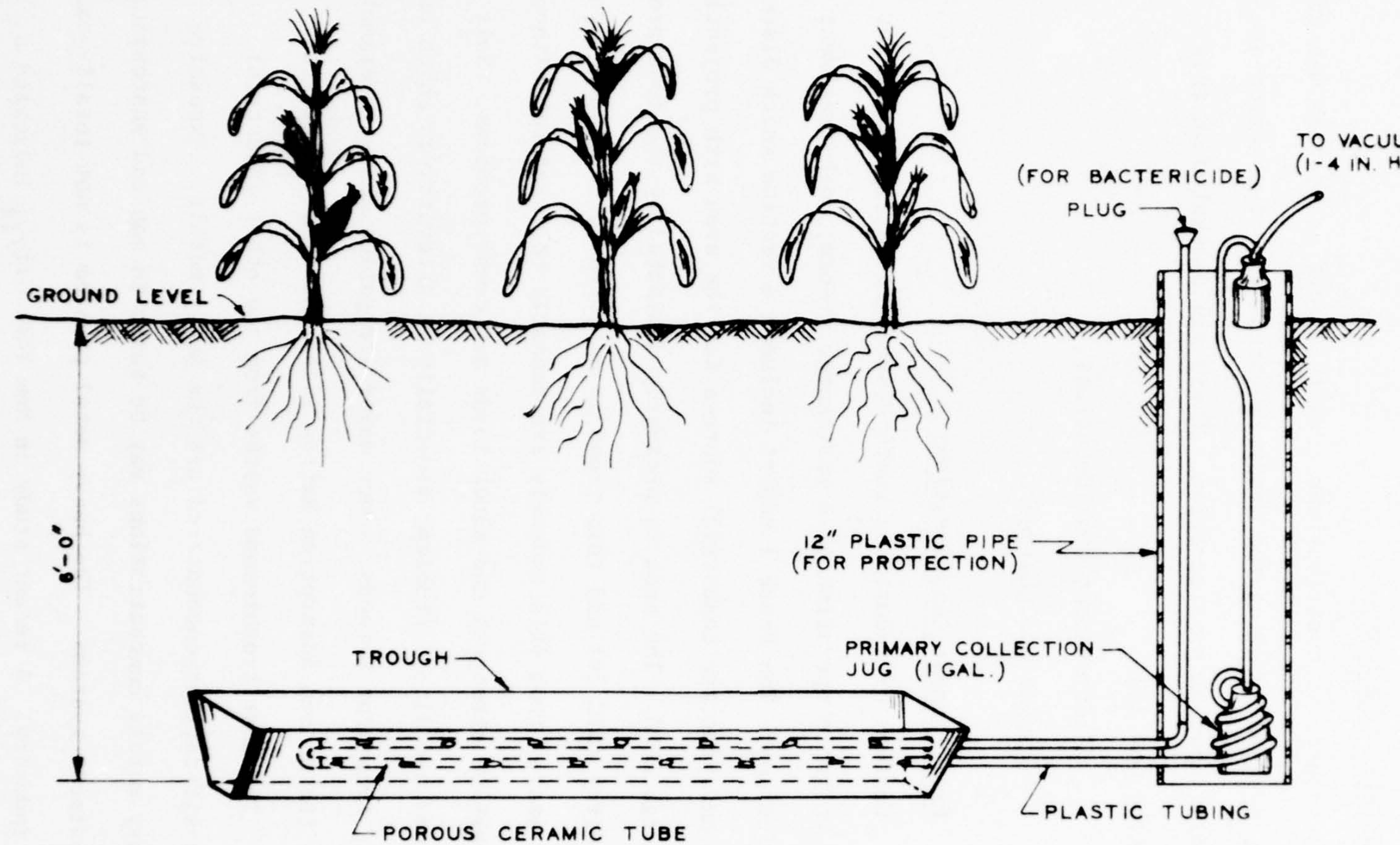
TABLE 81

CAPITAL COST FOR
DEMONSTRATION UNIT

Holding Pond	$ 5,000
Pump Station	7,500
Pipeline with Road Crossing	12,500
Center-pivot machine	30,000
Monitoring Equipment	8,000
Miscellaneous	5,000
Sub-Total	$ 68,000
25% Contingency	17,000
TOTAL	$ 85,000

Conclusion

A demonstration of land treatment technology should be made in the study area before a final committment is made involving this technology. The use of a site at Boys Town is proposed as a good location for such a facility.



OMAHA DISTRICT
CORPS OF ENGINEERS
HAVENS AND EMERSON, LTD.

FIGURE 20
VACUUM EXTRACTOR

INDUSTRIAL CONCERNS

Industrial contributions greatly affect wastewater management systems. During the study two areas were recognized as needing special consideration. These are presented in this section and are:

Pretreatment Considerations

Sewer Use Charges

Pretreatment Considerations

Control of industrial waste discharges is imperative for the reliable operation of a wastewater system; both treatment and collection. The Phase I report includes a section which discusses and analyzes the industrial sources for the area with projections through 2020. The area is presently dominated by the food processing industry (SIC 20) and this trend is expected to continue. Generally, the wastes from this industry are amenable to treatment although excessive strengths and shock loads may cause problems. Salt brines are also a problem, especially in alternatives which use land treatment methods, since major irrigation quality parameters are the Sodium Adsorption Ratios (SAR) and dissolved solids.

The most troublesome wastes from the other industrial classifications encountered are the heavy metals. Excessive heavy metals concentrations may be toxic to man and wastewater treatment systems. The heavy metal problem is not totally caused by industry. A recent study in New York City[14] indicates a significant amount of metals originate in the residential areas.

The study involves the wastewater received at the municipal treatment plants. Five sources of metals (water supply, electroplaters, other industries, residents and runoff) were analyzed for copper, chromium, nickle, zinc and cadmium. The results of the study indicate that the residential areas contribute from 25% to 49% of the total load while the industrial sources contribute 19% to 65% of the total load. The residential load is carried in a flow of 1,013 mgd and the industrial load is associated with a flow of 42 mgd. Therefore, the results indicate generally equivalent loads for industrial and residential sources, but the industrial load is carried in only 4% of the flow or about 25 times the concentration of the residential flow.

The New York study obviously cannot be applied directly to the Omaha area, but the results are significant and show the value of a continued industrial monitoring in the study area to evaluate sources and determine the most cost effective method of load reductions.

The removal of heavy metals is generally accomplished by chemical addition to provide precipitation at high pH. This method is effective at high concentrations and low flows but after dilution in a wastewater system the chemicals required and sludges produced cause excessive expense. Removal at the source is more cost-effective than removal at a municipal treatment plant and future planning should emphasize treatment of industrial sources prior to discharge to local sewers. No critical condition is apparent with existing data but surveillance of metals concentrations should be continued in order to develop the data source necessary to spot possible problems in the future.

Pretreatment practices are also appropriate for some of the other industries that exist in the area. These can vary from simple grease removal system to more complex pH adjustment and precipitation methods. Although not a pretreatment method, good housekeeping also has been shown to reduce troublesome discharges in some instances. The USEPA has prepared and is preparing effluent guidelines for several industrial classifications as a requirement of Public Law 92-500. These guidelines will provide future direction to the planning process.

Reducing the problems associated with food processing wastes can be attacked in several ways.

1. Reduce water consumption.
2. Recovery of blood and paunch in dried form.
3. Recovery of grease.
4. Centralized pretreatment.
5. Diversion to municipal wastewater plant.

These alternatives are generally understood and will not be discussed individually. Two developments in the area of pretreatment of food processing wastes have occurred in the study area; the Omaha centralized meat packing waste processing plant and the Council Bluffs blood and paunch drying plant. The experiment at the Beefland International Plant in Council Bluffs has shown that collecting and drying blood and paunch reduced the BOD load significantly and at a reasonable cost.

Centralized pretreatment of meat packing and food processing wastes has been implemented in the Omaha Pollution Control Corporation Plant. The plant was designed to treat 15 mgd of water-carried paunch, blood and grease from eighteen processors. The plant consists of a solids flotation process for separation of solids and a solids recovery process for recovery of by-products.

Unfortunately, the plant has been plagued by operational problems. Litigation presently exists concerning the solids recovery section and it is presently inoperative. The separation process stream is operating essentially as designed but extreme corrosion has caused numerous equipment breakdowns. The separated paunch is burned or hauled to landfill and separated grease is periodically hauled to Des Moines, Iowa, by a scavenger firm. The exact source of the excess corrosion is unknown but the waste is characterized by high chlorides and low pH. Further investigation is required to locate the source of the salts, and to control the corrosion problem.

Maintaining this plant to pretreat the strong and variable wastes from the food processors is beneficial to the total wastewater management system if the corrosion sources are eliminated. Such a facility will stabilize the flow and load to the downstream plant, treat a more concentrated waste, and prevent build-up of grease and gross solids in the downstream sewers, which will provide better reliability, better cost effectiveness, and reduce maintenance problems. If the source of corrosion is not eliminated, further studies are required to determine what

steps are required to treat the corrosive substances at the OPCC Plant or at the major municipal plants.

Sewer Use Charges

This section deals with the control and assessment of charges for industrial waste discharges in the study area. Although a detailed rate study is not appropriate for this level of study, direction should be provided. The Public Law 92-500 of 1972 specifically refers to revenue charges and will direct future rate studies. The Law states that USEPA will not approve grants for treatment works unless assured that the applicant will adopt a system of charges to assure that each recipient of waste treatment services will pay its proportionate share of the costs of operation and maintenance (including replacement) of any waste treatment services provided, and that costs should reflect all factors including strength, volume and flow rate characteristics of waste.

With this in mind, the City of Omaha contracted to R.W. Beck and Associates to develop a rate study to develop projected revenue requirements to pay the cost of expansion maintenance and debt retirement associated with the sewer system. The results of the study was reported in November 1973 entitled "Cost of Service and Cost Recovery - Sanitary Sewer System". The study details the proposed rate structure which is based on PL 92-500 and calls for a base charge with additional charges for abnormally high strength. The quantification of strength requires significant

monitoring of commercial and industrial flows and quality. Some of the recommendations of the study include:

1. The City adopt the proposed Sewer Use Charges and place them into effect by November 1, 1973.
2. The City continue the program of monitoring and testing of commercial and industrial waste discharges to obtain data from which abnormal wastes loadings can be determined.
3. The City instigate a program for the continual classification of new sewer users as they become connected to the sewerage system or existing customers as their basic user classification status changes or is modified.
4. The City adopt a policy enabling it to exercise complete control in approval of methods, procedures and sampling schedules performed by testing laboratories other than the Industrial Waste Testing Department of the City.

The City of Lincoln, Nebraska has in effect a system similar in general concept to the proposed Omaha rate structure. The Lincoln experience with the concept of charges based on flow and strength rather than flow alone is detailed here because of its proximity to the study area and because some preliminary data concerning the effects of the change-over is available. The Lincoln details are not proposed for Omaha since rate structures

are unique to each different situation, but the experience is beneficial to understanding the rate structures.

The two basic ordinances which define the Lincoln requirement are presented in Appendix E. Ordinance #9965, approved May 5, 1971, defines the discharges which can and cannot be placed in the Lincoln sewer system. The ordinance provides in Section 17.58.060 and 17.58.070 that the Director may require pretreatment, control of quantities and discharge rates or payment to cover the added costs of certain discharges. Pretreatment facilities are at the owners expense. The Director may also require construction and maintenance of a sampling station at the owners expense (17.50.100). The City performs the sampling.

Ordinance #10130, approved March 30, 1971, addresses all wastewater charges. These charges are split into two types; basic sewer use charge (17.60.030) and sewer use surcharge (17.60.034). The basic charge is a flat rate based on flow. The surcharge is charged on excess strength of BOD and suspended solids with provision for additional parameters in the future. Section 17.60.038 defines the surcharge formula. To spread the burden of the charges defined by the new ordinances, the increase from preceding annual rates are phased over a maximum of three years. The maximum increase for the first year after the ordinance is 100% of the base year, or the year preceding the passage of the ordinance. The second and third year maximum increase over the base year is 200% and 300%, respectively.

Table 83 shows the effect of the passage of the ordinances on revenues as reported by the City of Lincoln[15]. The industrial contribution to the wastewater system is about 14% of the flow, 33% of BOD and 15% of suspended solids in the base year of 1971 and the first year of new charges, 1972. In 1971, the industrial revenue was 10.1%. This revenue increased to 14.8% in 1971 with the limitation of a 100% increase in individual charges. Without the limitation, the industrial contribution would have been 16.7% which has been realized in succeeding years. The City is presently satisfied that the users of the system are paying their proportionate share of the treatment and collection costs.

Conclusions

The study has shown no critical problem with industrial discharges except in the area of dissolved salts. Excessive concentrations have been observed in the Council Bluffs plant as well as the OPCC Plant, and probably contribute to the corrosion problem at the OPCC Plant. Continued monitoring of industrial discharges is recommended, however, to broaden the available data base and anticipate future problems.

Assuming the corrosion sources are eliminated from the system, the OPCC Plant should be retained to treat the high strength and variable loads from the contributing industries. Further investigations are required if the corrosion sources cannot be eliminated.

TABLE 82

EFFECT OF ORDINANCES ON REVENUE
LINCOLN, NEBRASKA (a)

	1971 (b)	1972 (c)
Total Wastewater Flow (gal)	8,058,062,000	8,088,032,000
Major Ind. Wastewater Flow (gal)	1,180,266,000	1,159,780,500
Major Ind. Contribution (%)	14.6%	14.3%
Total Wastewater BOD (lb/yr)	22,174,200	20,238,500
Major Industrial BOD (lb/yr)	7,257,030	6,732,900
Major Ind. Contribution (%)	32.7%	33.3%
Total Wastewater SS* (lb/yr)	23,490,300	28,662,400
Major Industrial SS* (lb/yr)	3,409,090	4,228,340
Major Ind. Contribution (%)	14.5%	14.8%
WITHOUT 100% LIMITATION (d)		
Major Ind. Base Charges ($)	$ 163,476.29	$ 293,897.88
Industrial Surcharges ($)	--	61,360.48
Tot. Major Ind. Wastewater Charges ($)	163,476.29	355,258.36
% of Total Possible Revenue without Limitation (d)	--	16.7%
Tot. Major Ind. Wastewater Charges ($)	163,476.29	355,258.36
Corr. for 100% Increase Limitation ($)	--	- 40,305.36
Total Major Ind. Revenue ($)	163,476.29	308,953.00
Total Wastewater Revenue ($)	$1,615,326.20	$2,087,180.83
Total Major Ind. Revenue ($)	163,476.29	308,953.00
% Major Ind. Revenue Contribution (%)	10.1%	14.8%

*Suspended Solids

(a) Data is based on average values, except for flow and revenue values.

(b) Base year - Feb. 1, 1974 through Jan. 31, 1972 (before Ordinance changes).

(c) First year after base year - Feb. 1, 1972 through Jan. 31, 1973 (after Ordinance changes).

(d) To phase-in the new rate structure the maximum annual increase in wastewater charge to a customer was limited to 100% the first year, 200% the second year, 300% the third year and no limit thereafter. Several customers were faced with a 200-300% increase with the new rates.

NOTE: Industrial revenue contribution would have increased from 10.1% to 16.7% if there was no limitation(d). In succeeding years this increase was realized.

The appropriate authority should proceed to develop a sewer use charge system which adheres to the current law in order to maintain Federal funding.

WATER CONSERVATION PRACTICES

As part of the Urban Study, Henningson, Durham and Richardson has completed a Regional Water Supply Study of the Metropolitan Omaha-Council Bluffs area. One of the findings of this study which has a direct effect on the wastewater management study deals with potential water conservation practices.

Residential Flow Reduction

The HDR_{16} study indicates that although forecasted water requirements do not critically approach available supplies, conservation and reuse of the water resources should be considered. Certain conservation efforts affect wastewater management due to a reduction of the domestic production of wastewater. Several structural and non-structural methods of water use reduction are considered in the study. Table 84 shows the possible effect that some of these methods have on the flow coming from the dwelling unit, taken from the Water Supply Study.

Two non-structural methods shown in the table concern the price of water and the elimination of the flat rate structure. Generally, an increase in price of water or the requirement of payment based on use will decrease the amount of water used. An increase in price of 50% is assumed by HDR to be required for a long-term reduction of use.

One structural method involves the voluntary or required incorporation of water-conserving fixtures into homes. The

effect of three such devices are shown in the table: water conserving toilets, shower heads and washing machines. Another structural method would require the use of a dual supply system. Essentially all water used in the study area is treated to drinking water standards while only 10% of the water used requires this treatment. Although this system is interesting from a supply standpoint, wastewater production would probably be unaffected.

TABLE 83

WATER USE REDUCTION

Conservation Method	Sewage Flow Reduction (%) Per Dwelling Unit
Pricing of water (50%) increase in cost	5
Metering of "flat rate" areas	25
Water conserving devices	
Toilet	19
Shower heads	13
Washing machines	7
Dual Water Supplies	0

Effect of Flow Reduction on Cost

If all the residents of the area were to use all the water conserving devices shown in Table 84, a total reduction in flow from the household would be 39%. This section investigates the possible cost reduction associated with this 39% reduction in household flow. Several factors need to be considered, including:

Extent of water conservation device usage on an areawide basis.

Extent of industrial and commercial flow to treatment plant.

Economy of scale in the treatment plant.

Flow-dependent treatment processes.

Extent of usage of water conservation devices - The implementation of conservation practices can be accomplished by voluntary or legal means. Both of these depend on public acceptance. These means may be accepted in new construction, but placement in existing structures would be very difficult to enforce. Voluntary action would not be effective. A full 39% reduction of household flow on an areawide basis is unlikely.

Extent of industrial and commercial flows - Flow to the treatment plant includes industrial, commercial and infiltration contributions as well as the household flows. The percentages of each vary for each individual treatment plant. The older, large plants have a much smaller percentage of residential flows than the smaller non-urban plant and a reduction of residential flow will have little effect on cost.

Economy of Scale - In the smaller plants, a reduction in flow will not produce an equal reduction in costs because unit costs increase at smaller sizes. In larger plants, this economy of scale is not as pronounced.

Flow dependent treatment processes - Treatment plant processes are sized based on two general parameters: Flow and pollutant load. Settling tanks and chlorination facilities are

examples of processes in which flow is the prime design parameter and for which economies are possible by reduction in flow. Aeration and sludge handling facility design are based primarily on a pollutant load, which is not affected by water conservation. Thus, these processes would not be affected by the reduction in a major way.

If full areawide implementation of flow reduction devices were possible by 1995, the 39% reduction in residential flow would result in a net flow reduction of about 16%, 19% and 36% at the Missouri River Plant, Mosquito Creek Plant, and Papillion Creek Plant, respectively. The variation is due to the flows not affected by such devices. The minor and non-urban plants would generally receive the higher net reduction.

The Papillion Creek Plant (most affected in flow) was evaluated to determine the possible cost reduction. The analysis indicated a capital cost reduction of 9% and an O&M reduction of 13%. An analysis of the Minor Urban process indicates reductions of 13% and 14% for capital and O&M, respectively, assuming full implementation resulting in 39% reduction in the residential flows.

Although individual studies would be required to determine specific cost reductions, this brief analysis indicates possible cost reductions of 10% - 15%, assuming a 39% domestic flow reduction. Although such a reduction may be possible, there is considerable question as to the legal and social feasibility of fully implementing such a program.

Conclusions

The implementation of water conserving devices in individual households in the study area would have a small effect on the costs of the plans presented in the study. The uncertainty of such flow reductions precludes designing for these reduced flows. If major reductions were accomplished over the planning period, an extension of the design life of some of the plants may occur which could be beneficial.

PAPILLION RESERVOIRS

Appendix A presents a plate which shows the location of the proposed Papillion Reservoirs. These reservoirs will serve dual functions of flood control and recreation, which are addressed in other portions of the Urban Study. The effect of the wastewater management plans on the Reservoir water quality was discussed in Phase I. Controls were proposed in Phase I to protect the reservoirs drainage area. The controls included:

1. No Wastewater treatment plants upstream of a reservoir.
2. No Stormwater treatment basins upstream of the reservoirs.
3. Good agricultural practices consisting of slope terracing, contour farming, strip cropping, reducing barren soil surface areas and impoundment controls.
4. Proper shoreline management consisting of bank stabilization, borden grasses and buffer zones.

The controls suggested could reduce the nutrient load to the stream to about 20% of the existing load. Remaining concentrations are not likely to create serious problems in the flowing stream. However, when the waters are impounded, a more complicated situation is created which will cause major changes in the ecosystem.

Lakes can be placed in several classes. The typical eutrophic lake is shallow, contains an abundance of nutrients producing heavy growth of aquatic plants, large populations of coarse fish, and highly organic sediments and may exhibit

low oxygen concentrations in the deeper areas. The opposite classification is the oligotrophic condition, which is characterized as a comparitively deep lake, low in nutrients and plant growths, low fish population, low in organic sediments and higher oxygen levels throughout.

Artificial or cultural eutrophication refers to the addition of nutrient supplies through human activity and to the resulting effect of these nutrients. Continued cultural eutrophication will eventually produce a major deterrent to the recreational use and aesthetic enjoyment of the water. If the controls proposed in this study are implemented, cultural eutrophication will be virtually eliminated but the reservoirs will reach an equilibrium state classified between the oligotrophic and eutrophic conditions.

Water quality data presently available in the Papillion streams indicates natural background nutrient levels in the Papillion watershed sufficient to support abundant growth levels of aquatic plants. Therefore, with the controls proposed the reservoirs will probably show evidence of enrichment relatively soon after filling. In time, which will vary somewhat for the different reservoirs, the nutrient input, turbidity and sedimentation factors will create a state which will tend toward the eutrophic condition. An intensive study would be required to predict, with confidence, the future condition of the reservoirs and also the recreational and aesthetic value. An oligotrophic lake may be better suited to water contact sports, whereas,

a partially eutrophic lake may provide better fishing. A fully eutrophic lake is virtually useless for recreational purposes.

Several factors are involved in the future state of the lakes. Two of these are the depth to volume ratio and the nutrient input. The depth to volume ratio in man-made lakes, such as the Papillion reservoirs, is controllable within limits. The controls proposed in the study will remove the major nutrient inputs but the natural inputs will remain.

Several parameters associated with nutrient input are needed for the maintenance of aquatic plants. Some of these are discussed in the following section.

Algal Growth Parameters

Phosphorus concentrations as low as 0.01 mg/l are believed to be capable of supporting algae blooms.[17] Available sampling information on the Papillion shows minimum values in excess of this level, even in areas where man-made loads are at a minimum. These minimum values indicate a high background level may exist due to naturally occurring processes and added soil nutrients.

Nitrogen is also required for algae blooms at approximate lower limits of 0.30 mg/l of inorganic nitrogen. The nitorgen input from the air through nitrogen fixation can be as high as 5 lb./acre/yr.[18], or approximately 0.92 mg/l/year, assuming that growth can occur in the upper two feet of the lake.

Algae can utilize CO_2 as a carbon source at concentrations much lower than those present from atmospheric equilibria.[19]

Also, several trace elements are required for algae growth. These are generally available in groundwater, and the initial algal growth in reservoir No. 16 indicates that they exist in adequate quantities in area waters.

A detailed analysis of the potential problem will depend on the final individual concentrations as well as the relationship between these parameters. Although a prediction of the future state of a lake is not possible without exhaustive study, the proposed controls will significantly reduce the potential for cultural eutrophication and improve the condition of the impoundments. Additional studies of the Papillion reservoirs are now being undertaken by the Corps of Engineers.

Control Measures

Temporary controls can be used to eliminate isolated or short-term problems due to extreme eutrophication. These are listed below:

1. Herbicides and algaecides[17]: Copper sulfate and other herbicides are used in lakes to control the growth of algae, but have shortcomings, such as toxicity to living organisms in excessive concentrations. Also, these chemicals may accumulate in bottom muds in insoluble compounds, may be corrosive to paint and equipment and may have other side-effects. Care should be taken in use of algaecides and herbicides since over-killing algae at one time may cause an oxygen

deficiency due to decomposition of the dead algae.

2. Mixing: Mixing of the water body has two major impacts; destratification and oxygenation. Destratification may cause an acceleration of algal successions due to the maintenance of nutrient levels in the upper surfaces. However, mixing the oxygen-rich upper water layers with the lower water layers maintains an oxygen level at the water-sediment interface which will prevent reduction and release of nutrients from the sediment. Therefore, nutrient laden materials reaching the sediment will be confined and unavailable for algal growth.

3. Dredging: Dredging deepens an area in a lake to a depth that will prevent growth of larger plants, and removes accumulations of nutrient rich organic sediments. However, the dredging process liberates nutrients at a high rate to the rest of the lake water and often triggers algal blooms.

4. Harvesting[17]: Methods and equipment are available for removal of aquatic plants. These include reservoir drawdown and drying, burning, hand-pulling, hand-cutting, hand-raking, chain-dragging, hand-operated underwater weed saws, and power-driven underwater weed cutting and weed removal units. The cost of these methods should be weighed against the benefits since the harvested plants would contain some fertilizer value and certain types of algae make high protein feed for cattle.

5. Dilution: This is accomplished by using the lake water for localized irrigation on suitably receptive land near the reservoir. The land removes the nutrients and the "clean" groundwater flows back into the reservoir and dilutes the remaining nutrients.

6. Biological agents: Biological agents could be used to stop major growth of a nuisance organism. Examples are predator organisms and competitive organisms which reduce the numbers of nuisance organisms.

These control possibilities should be more fully evaluated in a more detailed analysis when temporary controls are required. The control method or combination of methods required will depend on each specific situation

Conclusions

The control measures proposed for all Plans should be incorporated in future planning to protect the Papillion Reservoirs. These controls will significantly reduce the potential for extreme eutrophication conditions. Temporary control methods are presented to reduce problems which may develop in particular areas.

F. CONCLUSIONS AND RECOMMENDATIONS

This study has presented the basic wastewater management parameters, and a range of alternative plans, has selected three basic plans and one major land treatment option, and has developed cost estimates for the preferred alternatives. In order to make final selection of a plan for implementation, this wastewater study must be integrated with the other portions of the Urban Study for interactions with water supply, recreation, flood control and other factors, and the integrated plans evaluated on environmental, social and economic bases. The staff of the Corps of Engineers will make the integration and evaluation as part of the Urban Study.

The results of this procedure will provide the public with the information required to choose an alternative to be implemented. The choice of the final alternative should be given highest priority. In carrying out this study, the need for further consideration of certain specific topics has become evident, which should be part of the continuing planning process. The following list presents recommendations which include both implementation of facilities and various studies required to aid the planning process. The list is based on the assumption that high levels of treatment will be required (in 1985) by PL 92-500 and that some degree of land treatment will be acceptable to the public. The list is arranged in order of priority, based on providing reliable operation of existing facilities,

meeting 1977 requirements, and providing wastewater treatment, combined sewer overflow treatment and stormwater treatment.

EARLY ACTION - PRIOR TO 1977

1. The major urban areas are presently progressing toward satisfaction of the 1977 requirements for secondary treatment. This progress should be continued.
2. Sewer use charges for all communities should be developed based on the requirements of PL 92-500 so that future grant applications will not be delayed.
3. Industrial flow and quality monitoring now exists in the area. Intensified and expanded industrial waste monitoring is needed to develop the data base required for industrial sewer use charges, and future designs of treatment systems.
4. The diversion structures along the Missouri River interceptors have frequent overflows of raw wastewater due to malfunctioning equipment. A system of automatic controls and restructured by-passes should be implemented to reduce these overflows.
5. The corrosion problem is very severe in the OPCC treatment plant causing reduced reliability and performance. A study of the contributing area should be performed to locate the sources, and to determine corrective measures to be taken to eliminate the sources.
6. A demonstration of land treatment technology should be implemented at Boys Town to evaluate the impacts of this

technology in the local climate and soil and with local agricultural practices.

7. The modeling in this report is based on existing data. These models should be verified at both low and storm flow conditions and the Missouri model should be extended farther upstream. Monitoring and surveillance programs should be developed to determine the quality of storm discharges and combined sewer overflows.

8. The natural inputs to the proposed Papillion Reservoirs should be investigated in a field study and incorporated into the current re-evaluation by the Corps of Engineers.

9. The future choice of the wastewater and stormwater management plan is highly depended on the flow condition in the Missouri River. Major upstream diversions will significantly influence the treatment costs for the area. This report should be directed to the appropriate agencies to show the cost impacts associated with such reduced flows in the River and further efforts should then be made to define future flows.

10. The effect of stormwater discharges on water quality is not well-defined. In this study the short-term stormwater discharges are evaluated on the same water quality standards developed for continuous wastewater discharges. Further investigations are recommended to determine the duration and magnitude of the impact of such discharges to determine

whether changes in the water quality standards are appropriate.

11. This report presents two basic methods of treating the Omaha Combined sewer overflows to the Missouri River. Both methods are very expensive and a choice is highly dependent on River flow and water quality requirements. Further evaluation of this area is required using an expanded and verified model, a refined definition of water quality requirements for storm flow, and refined River flow characteristics.

12. This study, in conjunction with the rest of the urban study, essentially satisfies the EPA technical requirements for 208 planning as defined in PL 92-500. The results of the study should be used as a base for the development of the 201 requirements for each of the facilities.

13. Continue to implement feedlot controls and to strive toward the increasing use of good agricultural practices to reduce the adverse effects from these sources on the local streams.

1977-1985

1. The results of the various studies should be integrated with the chosen alternative as part of the continuing planning process.
2. The wastewater plants should be upgraded to satisfy the high levels of treatment required by PL 92-500. Treatment requirements of the Major Urban plants for the water quality standards are highly dependent on Missouri River flow.
3. This wastewater management study shows that land application is the most viable at higher treatment levels and in the non and minor urban areas. If the Boys Town demonstration results are positive, land application should be given high priority in the selection of treatment for these areas.
4. Construct the upstream treatment facilities for the combined sewer areas of the Papillion creek basin and Council Bluffs area.
5. Implement a treatment system for abatement of pollution from the combined sewer overflows of the Omaha-Missouri River sewerage system using the results of the early action studies.
6. Implementation of a major land treatment option for the major urban area depends upon the results of the evaluation portion of the Urban Study, the Boys Town land treatment demonstration, the industrial waste monitoring program, and public acceptance. If these results are positive, implementation of a major land treatment system for the

western sites should be given high priority in the selection of treatment for the urban flows.

7. Construct the upstream treatment facilities for the urban stormwater runoff as required by future standards and community development.

G. APPENDICES

APPENDIX A

GROWTH CONCEPT PLATES AND PAPILLION RESERVOIR PLATE


NEBRASKA
ORUM
BLAIR
KENNARD
FORT CALHOUN
DESOTO BEND
WASHINGTON COUNTY
DOUGLAS COUNTY
A 2020
A 1995
BENNINGTON
VALLEY
WATERLOO
ELKHORN
OMAHA
MISSOURI
COUNCIL BLUFFS
PLATTE
RIVER
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DOUGLAS COUNTY
SARPY COUNTY
PAPILLION
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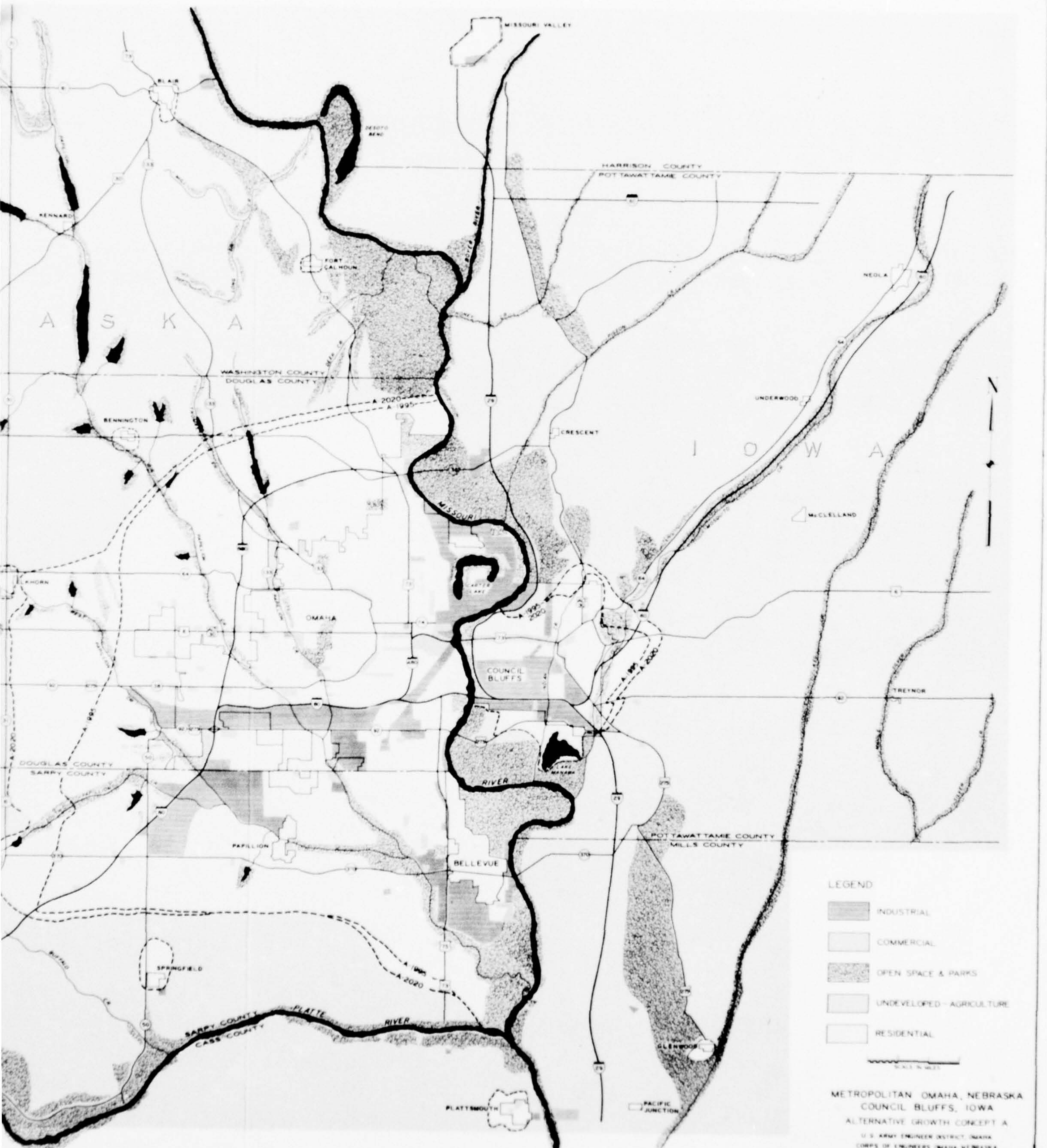
PLATTSMOUTH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TREYNOR
DOUGLAS COUNTY
SARPY COUNTY
LAKE MANAWA
RIVER
PAPILLION
POTTAWATTAMIE COUNTY
MILLS COUNTY
BELLEVUE
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INDUSTRIAL
COMMERCIAL
OPEN SPACE & PARKS
UNDEVELOPED - AGRICULTURE
RESIDENTIAL
SPRINGFIELD
SARPY COUNTY
CASS COUNTY
PLATTE
RIVER
GLENWOOD
PLATTSMOUTH
PACIFIC JUNCTION
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
ALTERNATIVE GROWTH CONCEPT A
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA NEBRASKA

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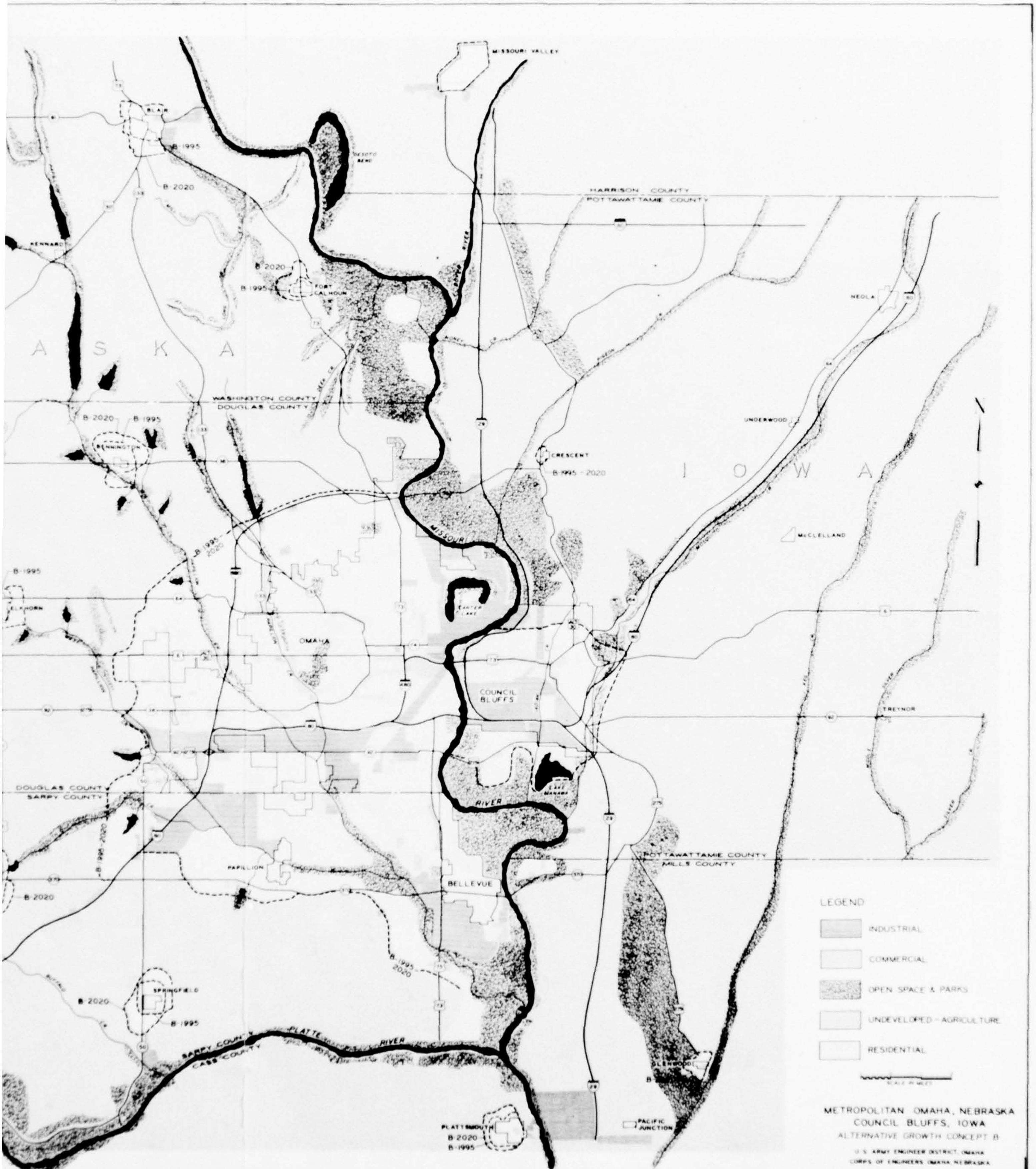

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LEGEND
INDUSTRIAL
COMMERCIAL
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UNDEVELOPED - AGRICULTURE
RESIDENTIAL
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
ALTERNATIVE GROWTH CONCEPT B
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

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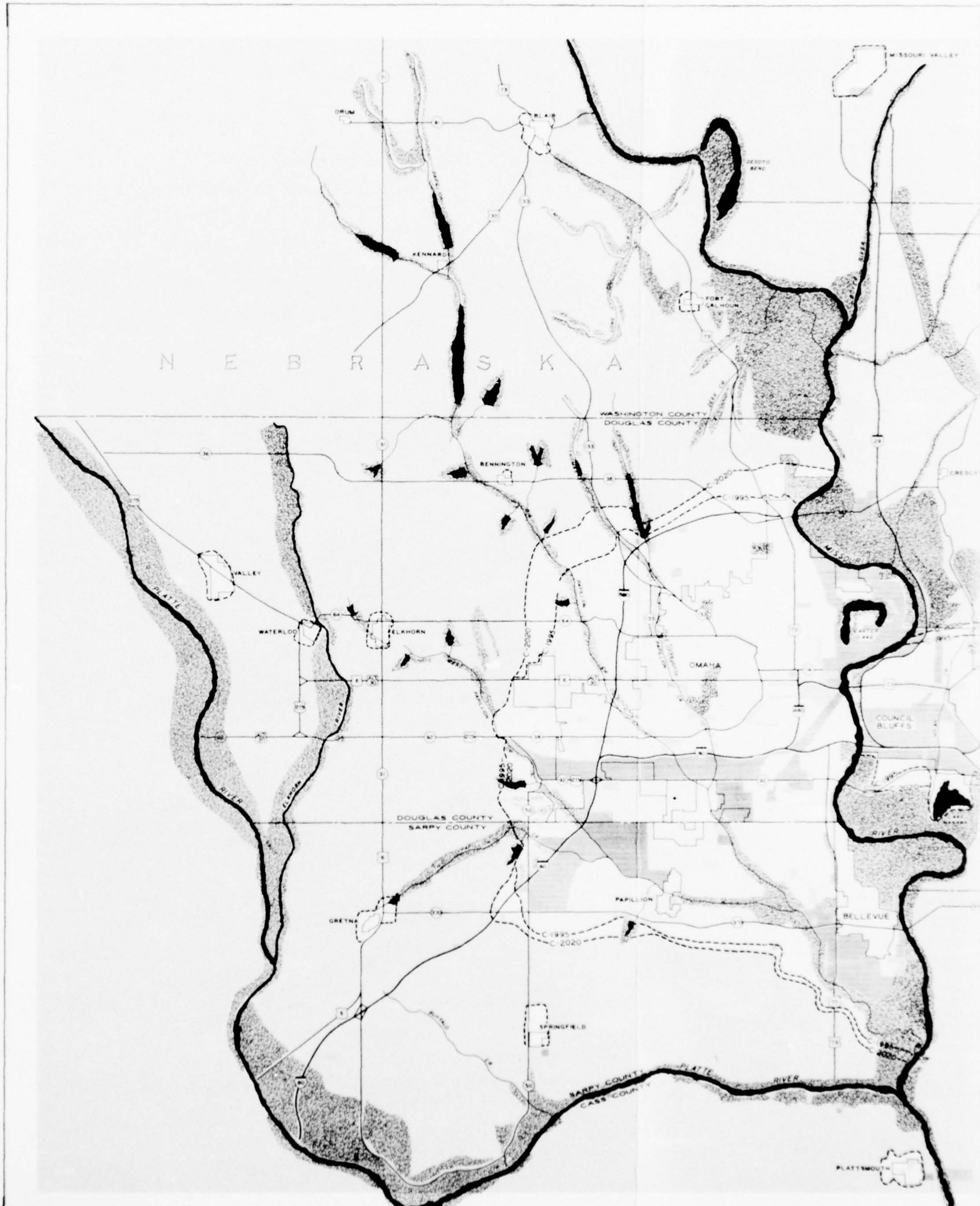

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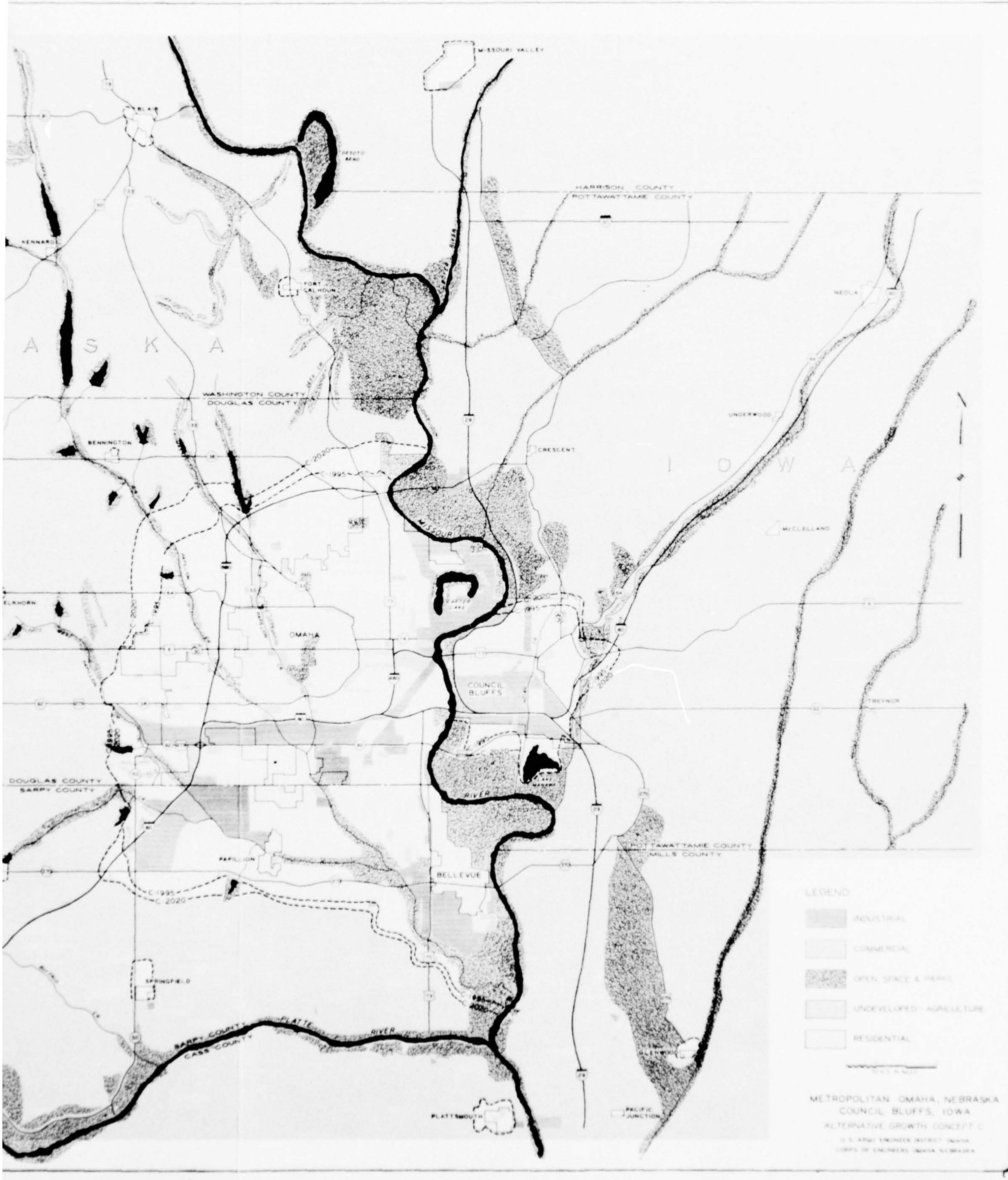
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UNDEVELOPED - AGRICULTURE
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COUNCIL BLUFFS, IOWA
ALTERNATIVE GROWTH CONCEPT C
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA NEBRASKA

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DESOTO BEND
WASHINGTON COUNTY
DOUGLAS COUNTY
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WATERLOO
ELKHORN
OMAHA
COUNCIL BLUFFS
CARTER LAKE
MISSOURI
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ELKHORN RIVER
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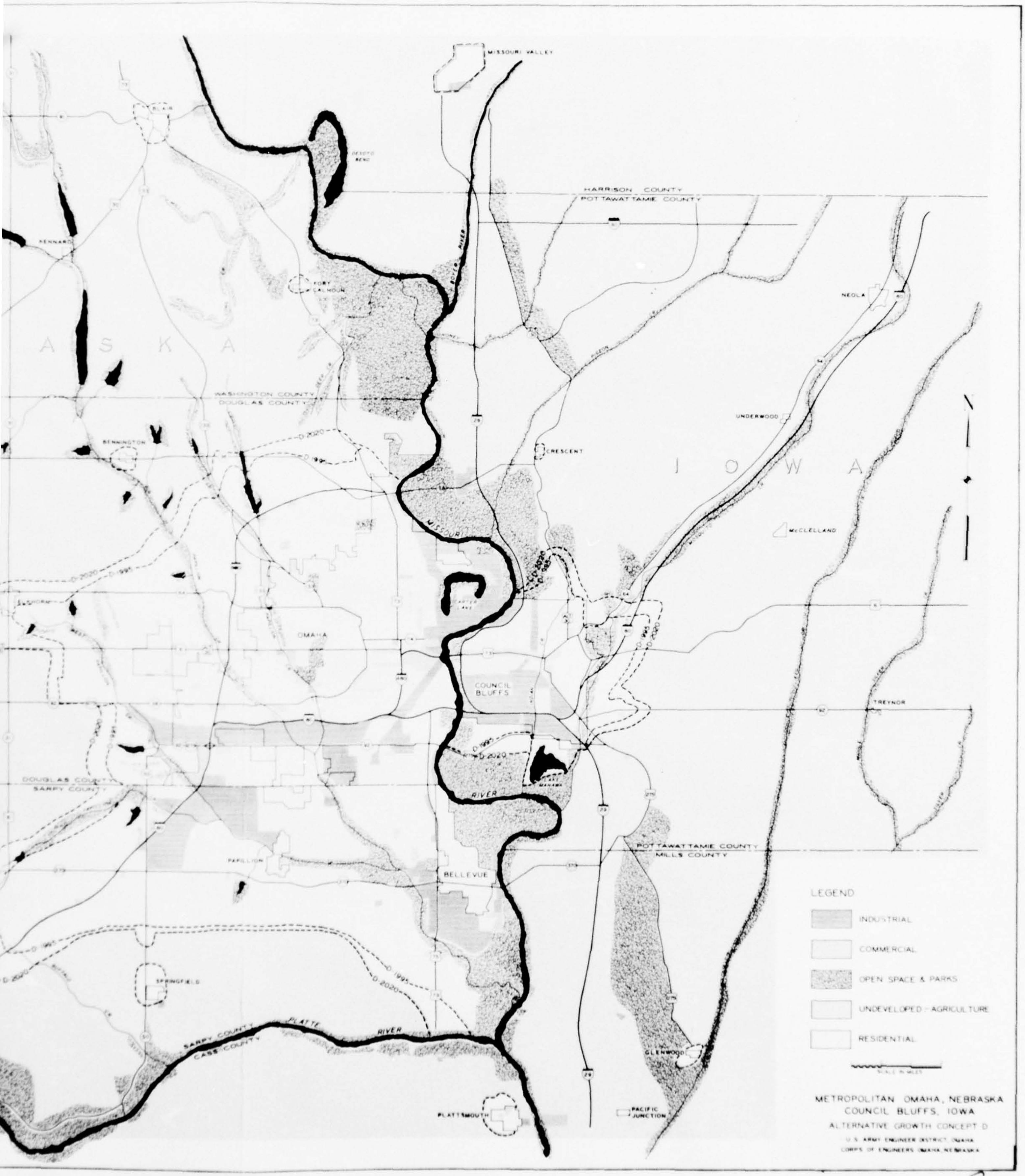

MISSOURI VALLEY
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COUNCIL BLUFFS
TREYNOR
DOUGLAS COUNTY
SARPY COUNTY
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MILLS COUNTY
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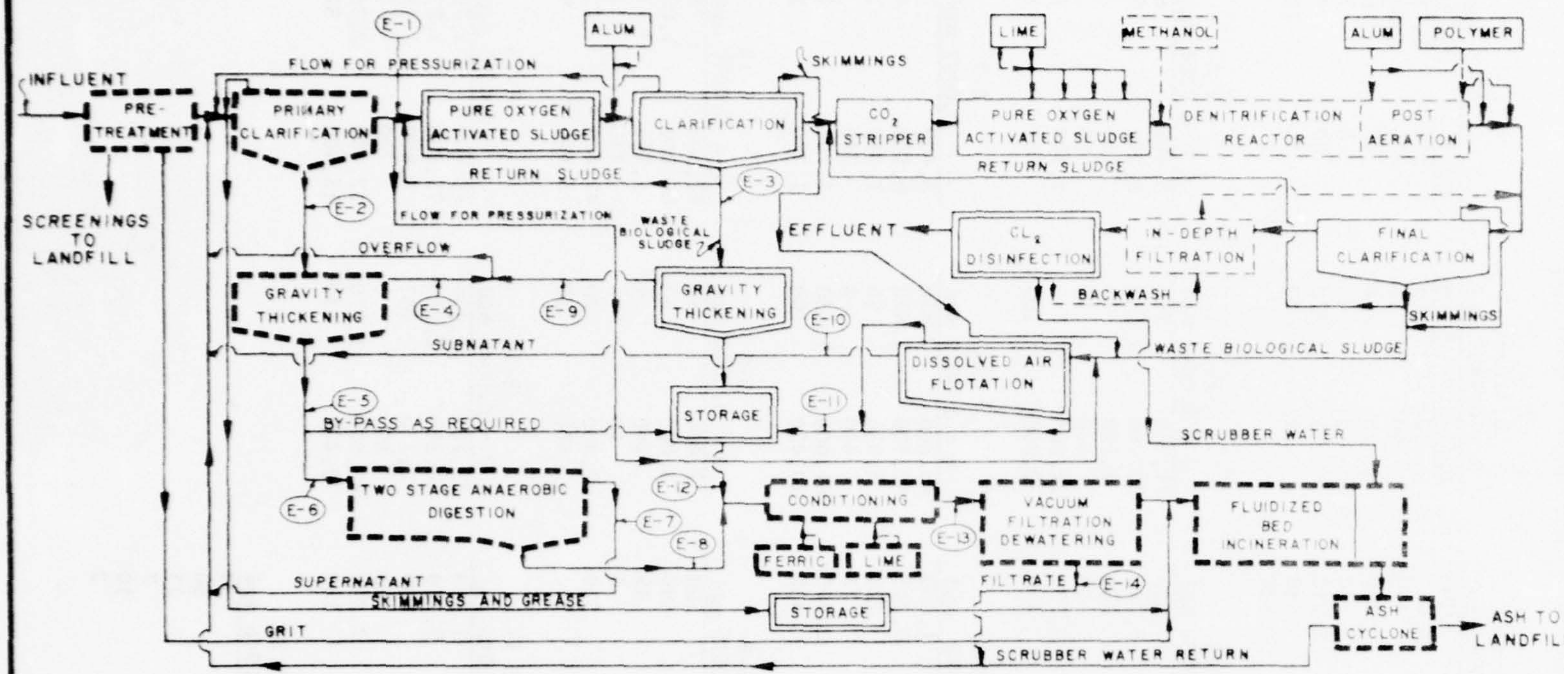
OPEN SPACE & PARKS
UNDEVELOPED - AGRICULTURE
RESIDENTIAL
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
ALTERNATIVE GROWTH CONCEPT D
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

2

PAPILLION CREEK AND TRIBUTARIES PROJECT

APPENDIX B

DESIGN SCHEMATICS AND MASS BALANCES



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

- ▬ ▬ ▬ ..... EXISTING AND / OR UNDER DESIGN
- ═══ ..... LEVEL 1
- ──── ..... LEVEL 2
- — — — ..... LEVEL 3

LEVEL 1
RES. & IND.
$Q_{INF} = 100$ MGD

HAVENS AND EMERSON, LTD.

FIGURE 1
PAPILLION CREEK
PLANT SCHEMATIC
OMAHA DISTRICT
CORPS OF ENGINEERS

MASS DIAGRAM
LEVEL I
RESIDENTIAL & INDUSTRIAL (PAPILLION)

	Influent		Effluent		E-1	
	Q = 1.0000 mgd		Q = 0.9985 mgd		Q = 1.0025 mgd	
Item	mg/1	#/Day	mg/1	#/Day	mg/1	#/Day
BOD	420	3,500	30	260	210	1,770
COD	770	6,420	90	730	400	3,330
TKN	45	380	26	214	35	289
P	8	70	6	48	8	70
VSS	385	3,210	25	220	90	770
ISS	65	540	4	30	15	130
OIL & GR.	110	920				

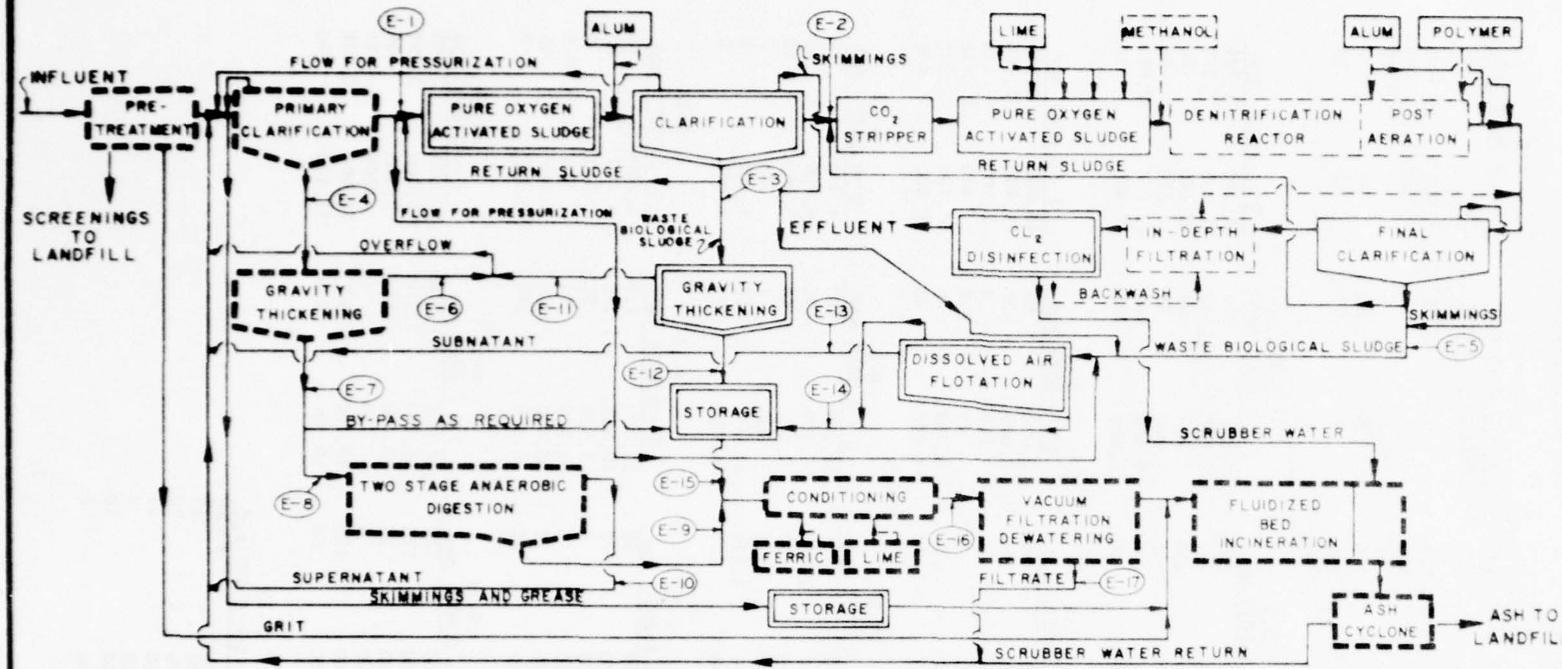
	E-2		E-3		E-4	
	Q = 0.0072 mgd		Q = 0.0041 mgd		Q = 0.0024 mgd	
BOD	31,300	1,880	21,900	750	3,000	60
COD	55,600	3,340	30,700	1,050	5,000	100
TKN	2,160	130	2,190	75	200	4
P	300	18	440	15	50	1
VSS	43,000	2,580	21,900	750	3,700	75
ISS	7,200	430	2,900	100	500	10

	E-5		E-6		E-7	
	Q =0.0048 mgd		Q = 0.0022 mgd		Q = 0.0007 mgd	
BOD	45,700	1,830	45,600	830	3,400	20
COD	80,900	3,240	80,100	1,470	6,800	40
TKN	3,000	120	3,050	56	1,880	11
P	425	17	440	8	340	2
VSS	62,200	2,490	61,600	1,130	1,700	10
ISS	10,700	430	10,400	190	1,700	10

	E-8		E-9		E-10	
	Q = 0.0015 mgd		Q = 0.0020 mgd		Q = 0.0020 mgd	
BOD	31,200	390	2,400	40	42,600	710
COD	55,200	690	3,000	50	60,000	1,000
TKN	3,600	45	240	4	4,260	71
P	400	5	50	0.8	840	14
VSS	44,000	550	2,400	40	42,600	710
ISS	14,400	180	600	10	5,400	90

	E-11		E-12		E-13	
	Q = 0.0046 mgd		Q = 0.0046 mgd		Q = 0.0061 mgd	
BOD	43,600	1,710	35,700	1,400	45,700	1,790
COD	70,900	2,780	58,200	2,280	75,800	2,970
TKN	3,300	130	2,730	107	3,800	150
P	590	23	590	23	700	28
VSS	53,300	2,090	43,600	1,710	57,700	2,260
ISS	8,400	330	8,400	330	13,300	520

	E-14	
	Q = 0.0046 mgd	
BOD	800	30
COD	1,600	60
TKN	600	23
P	180	7
VSS	300	10
ISS	50	2



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

- ▬ ▬ ······EXISTING AND / OR UNDER DESIGN
- ═══ ······LEVEL 1
- ─── ······LEVEL 2
- — — ······LEVEL 3

LEVEL 2
RES. & IND.
Q_{INF}=100MGD

HAVENS AND EMERSON, LTD.

FIGURE 2
PAPILLION CREEK
PLANT SCHEMATIC
OMAHA DISTRICT
CORPS OF ENGINEERS

MASS DIAGRAM
LEVEL 2

RESIDENTIAL & INDUSTRIAL (PAPILLION)

Item	Influent Q = 1.0000 mgd mg/l	#/Day	Effluent Q = 0.9998 mgd mg/l	#/Day	E-1 Q = 1.0070 mgd mg/l	#/Day
BOD	420	3,500	7	60	210	1,780
COD	770	6,420	9	75	410	3,410
TKN	45	380	0.7	6	35	290
P	8	70	0.4	3	8	70
VSS	385	3,210	7	60	90	770
ISS	65	540	4	30	15	130
OIL & GR.	110	920				

	E-2 Q = 1.0011 mgd		E-3 Q = 0.0059 mgd		E-4 Q =0.0073 mgd	
BOD	30	230	19,500	960	31,200	1,900
COD	80	690	27,200	1,340	55,400	3,370
TKN	23	193	1,950	96	2,140	130
P	2	17	1,080	53	310	19
VSS	20	190	19,500	960	42,500	2,590
ISS	7	60	5,600	275	7,400	450

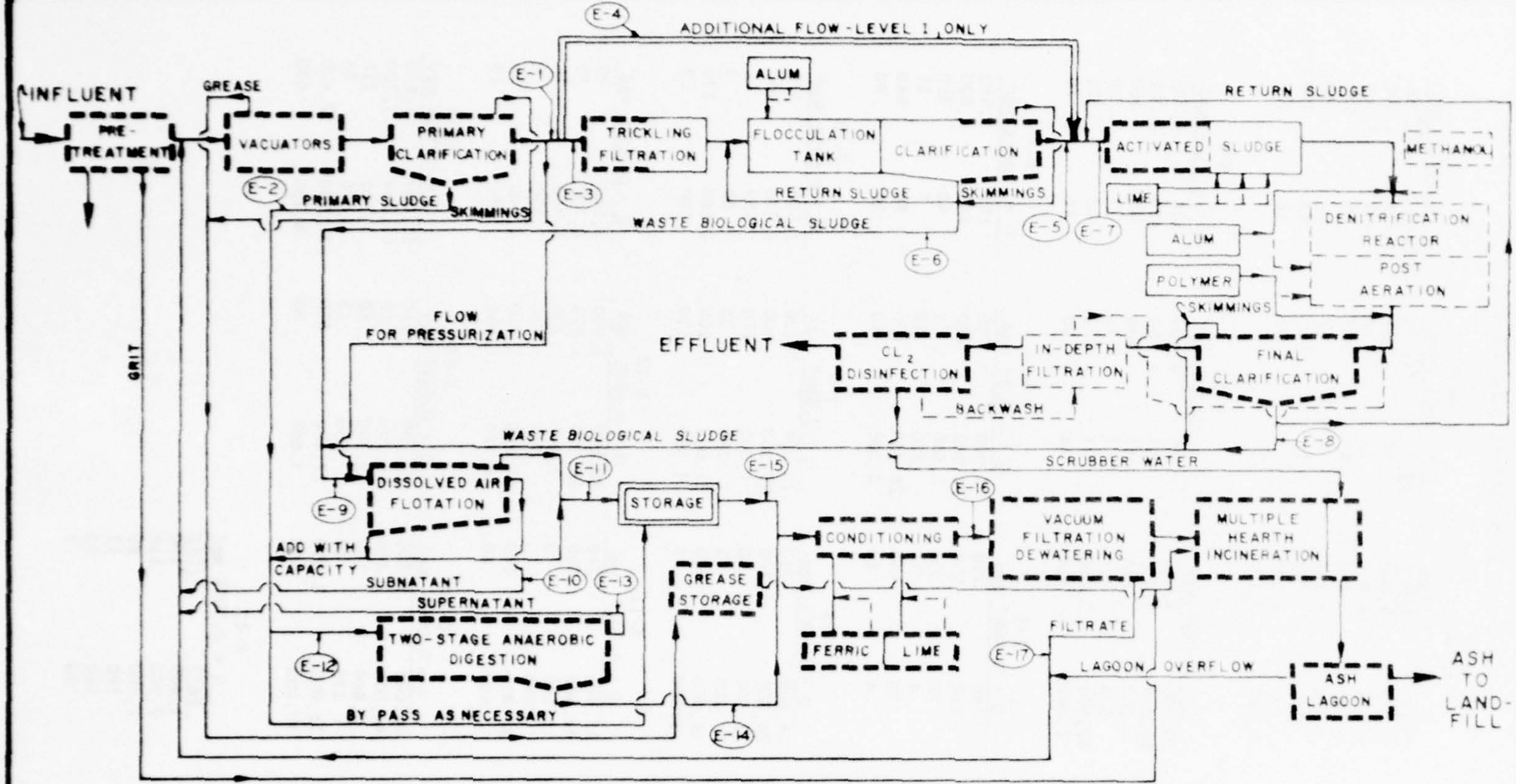
	E-5 Q =0.0013 mgd		E-6 Q = 0.0024 mgd		E-7 Q = 0.0049 mgd	
BOD	12,900	140	3,000	60	45,000	1,840
COD	17,500	190	5,000	100	79,800	3,260
TKN	1,290	14	150	3	3,100	126
P	830	9	40	0.8	440	18
VSS	12,900	140	3,700	75	61,700	2,520
ISS	6,900	75	1,000	20	10,500	430

	E-8 Q = 0.0022 mgd		E-9 Q = 0.0015 mgd		E-10 Q =0.0007 mgd	
BOD	45,000	825	31,200	390	4,300	25
COD	79,600	1,460	55,200	690	6,800	40
TKN	3,100	57	3,600	45	2,060	12
P	330	6	560	7	340	2
VSS	61,600	1,130	44,000	550	1,400	8
ISS	10,400	190	14,400	180	1,400	8

	E-11 Q = 0.0028 mgd		E-12 Q = 0.0031 mgd		E-13 Q =0.0007 mgd	
BOD	2,100	50	35,200	910	2,600	15
COD	3,000	70	49,500	1,280	3,400	20
TKN	210	5	3,520	91	340	2
P	130	3	1,970	51	140	0.8
VSS	2,100	50	35,200	910	2,600	15
ISS	400	10	10,200	265	1,370	8

	E-14 Q = 0.0006 mgd		E-15 Q = 0.0064 mgd		E-16 Q = 0.0079 mgd	
BOD	25,000	125	32,000	1,710	31,600	2,080
COD	35,000	175	50,800	2,710	50,800	3,350
TKN	2,600	13	2,700	143	2,520	166
P	1,600	8	150	8	990	65
VSS	25,000	125	37,800	2,020	39,000	2,570
ISS	13,000	65	10,700	570	11,400	750

	E-17 Q = 0.0077mgd mg/l	#/Day
BOD	600	40
COD	1,100	70
TKN	360	23
P	120	8
VSS	150	10
ISS	50	3



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

- EXISTING AND / OR UNDER DESIGN
- LEVEL 1
- LEVEL 2
- LEVEL 3

LEVEL 1
RES. & IND.
Q_{avg} 80 MGD

HAVENS AND EMERSON, LTD.

FIGURE 3
MISSOURI RIVER
PLANT SCHEMATIC
OMAHA DISTRICT
CORPS OF ENGINEERS

MASS DIAGRAM
LEVEL 1

RESIDENTIAL & INDUSTRIAL (MISSOURI)

Item	Influent Q = 1.0000 mgd mg/l	Influent #/Day	Effluent Q =0.9983 mgd mg/l	Effluent #/Day	E-1 Q =1.0078 mgd mg/l	E-1 #/Day
BOD	1,100	8,800	23	190	275	2,300
COD	1,900	16,000	76	630	453	3,800
TKN	97	810	32	270	45	380
P	15	130	5	40	7	60
VSS	940	780	18	150	94	790
ISS	780	6,500	2	20	16	130
OIL & GR.	1,100	9,100				

	E-2 Q = 0.0088 mgd		E-3 Q = 0.4717 mgd		E-4 Q = 0.5361 mgd	
BOD	30,000	2,200	275	1,100	275	1,200
COD	60,000	4,400	453	1,800	450	2,000
TKN	2,200	160	45	180	45	200
P	300	20	7	30	7	30
VSS	42,000	3,100	94	370	94	420
ISS	7,200	530	16	60	16	70

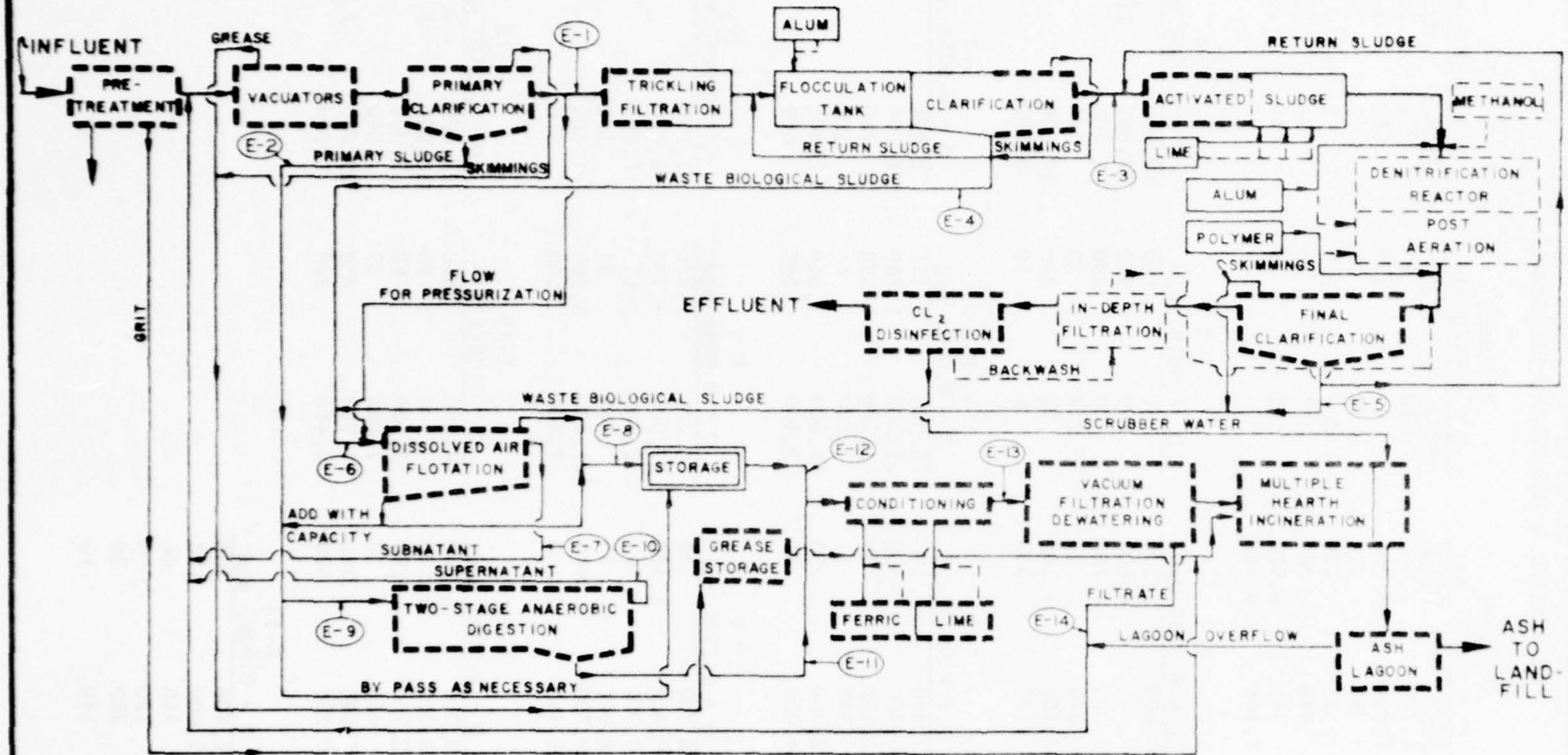
	E-5 Q = 0.4687 mgd		E-6 Q = 0.0030 mgd		E-7 Q = 1.0048 mgd	
BOD	60	230	28,000	700	185	1,550
COD	140	550	39,000	980	330	2,800
TKN	20	100	2,800	70	40	350
P	4	16	520	13	7	55
VSS	30	160	28,000	700	80	640
ISS	4	20	3,200	80	10	90

	E-8 Q = 0.0065 mgd		E-9 Q = 0.0095 mgd		E-10 Q = 0.0058 mgd	
BOD	14,600	790	14,000	1,100	2,500	120
COD	20,300	1,100	20,200	1,600	3,300	160
TKN	1,500	80	1,400	110	250	12
P	280	15	290	23	60	3
VSS	14,800	800	14,000	1,100	2,500	120
ISS	1,500	80	1,500	120	200	10

	E-11 Q = 0.0027 mgd		E-12 Q = 0.0098 mgd		E-13 Q = 0.0033 mgd	
BOD	32,800	740	30,600	2,500	2,500	70
COD	44,400	1,000	58,000	4,770	4,700	130
TKN	3,100	70	2,300	190	1,300	36
P	670	15	320	26	150	4
VSS	32,900	740	41,600	3,400	1,100	30
ISS	3,600	80	6,900	560	360	10

	E-14 Q = 0.0065 mgd		E-15 Q = 0.0027 mgd		E-16 Q = 0.0092 mgd	
BOD	24,000	1,300	27,100	610	25,000	1,900
COD	44,000	2,400	38,200	860	43,000	3,300
TKN	2,800	150	2,700	60	2,900	220
P	370	20	580	13	470	36
VSS	33,000	1,800	27,100	610	31,000	2,400
ISS	10,000	550	3,600	80	8,200	630

	E-17 Q = 0.0075 mgd mg/l	#/Day
BOD	1,600	100
COD	2,900	180
TKN	1,300	80
P	190	12
VSS	160	10
ISS	50	3



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

- ▬ ▬ ▬ ....EXISTING AND / OR UNDER DESIGN
- ═══ ....LEVEL 1
- ─── ....LEVEL 2
- – – – ....LEVEL 3

LEVEL 2
RES. & IND.
Q_{IN} = 60 MGD

HAVENS AND EMERSON, LTD.

FIGURE 4
MISSOURI RIVER
PLANT SCHEMATIC
OMAHA DISTRICT
CORPS OF ENGINEERS

MASS DIAGRAM
LEVEL 2

RESIDENTIAL & INDUSTRIAL (MISSOURI)

Item	Influent Q =1.0000 mgd		Effluent Q = 0.9980 mgd		E-1 Q = 1.0086 mgd	
	mg/l	#/Day	mg/l	#/Day	mg/l	#/Day
BOD	1,100	8,800	10	80	270	2,300
COD	1,900	16,000	40	330	450	3,800
TKN	97	810	2	14	45	380
P	15	130	0.7	6	7	60
VSS	940	780	7	60	90	790
ISS	780	6,500	3	25	15	130
OIL & GR.	1,100	9,100				

	E-2 Q = 0.0089 mgd		E-3 Q =1.0019 mgd		E-4 Q = 0.0067 mgd	
BOD	29,600	2,200	60	500	17,000	950
COD	59,300	4,400	190	1,580	23,800	1,330
TKN	2,200	160	35	290	1,700	95
P	270	20	2.4	20	720	40
VSS	42,300	3,140	20	200	17,000	950
ISS	7,100	530	6	50	3,000	170

	E-5 Q = 0.0039 mgd		E-6 Q = 0.0106 mgd		E-7 Q = 0.0056 mgd	
BOD	12,000	390	15,000	1,340	2,800	130
COD	16,900	550	21,300	1,880	4,000	190
TKN	1,170	38	1,500	130	280	13
P	340	11	540	48	110	5
VSS	12,000	390	15,000	1,340	2,800	130
ISS	4,000	130	3,400	300	600	30

	E-8 Q = 0.0041 mgd		E-9 Q = 0.0098 mgd		E-10 Q = 0.0032 mgd	
BOD	28,700	980	30,200	2,470	1,500	40
COD	40,400	1,380	57,900	4,730	3,000	80
TKN	2,900	98	2,300	184	1,200	33
P	1,000	35	380	31	190	5
VSS	28,700	980	41,400	3,380	1,100	30
ISS	6,400	2,200	7,300	600	370	10

	E-11 Q = 0.0066 mgd		E-12 Q = 0.0041 mgd		E-13 Q = 0.0107 mgd	
BOD	23,000	1,260	24,900	850	22,600	2,020
COD	43,000	2,370	34,800	1,190	38,000	3,390
TKN	2,700	150	2,500	85	2,000	180
P	450	25	1,000	35	560	50
VSS	31,600	1,740	24,900	850	29,000	2,600
ISS	10,700	590	6,400	220	9,000	810

	E-14 Q = 0.0087 mgd	
BOD	1,400	100
COD	2,600	190
TKN	910	66
P	120	9
VSS	280	20
ISS	140	10

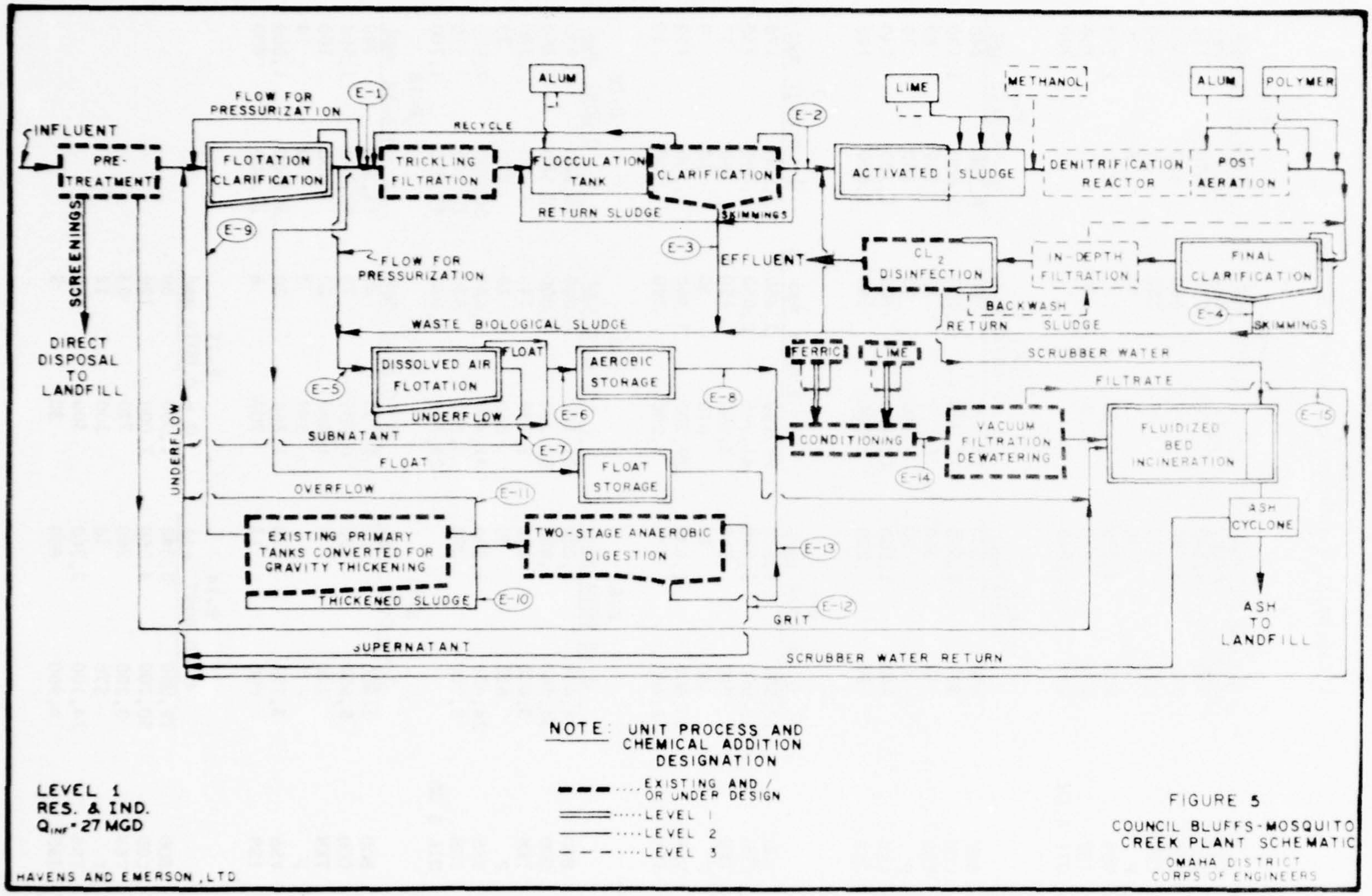


FIGURE 5

COUNCIL BLUFFS-MOSQUITO CREEK PLANT SCHEMATIC

OMAHA DISTRICT
CORPS OF ENGINEERS

MASS DIAGRAM
LEVEL 1
RESIDENTIAL & INDUSTRIAL (COUNCIL BLUFFS)

Item	Influent Q = 1.0000 mgd mg/l	#/Day	Effluent Q = 0.9975 mgd mg/l	#/Day	E-1 Q = 1.0171 mgd mg/l	#/Day
BOD	580	4,840	26	220	370	3,150
COD	1,050	8,750	79	660	620	5,300
TKN	60	500	34	280	53	450
P	8	70	5	40	8	70
VSS	500	4,170	22	180	210	1,770
ISS	100	840	5	40	40	360
OIL & GR.	240	2,040			20	200

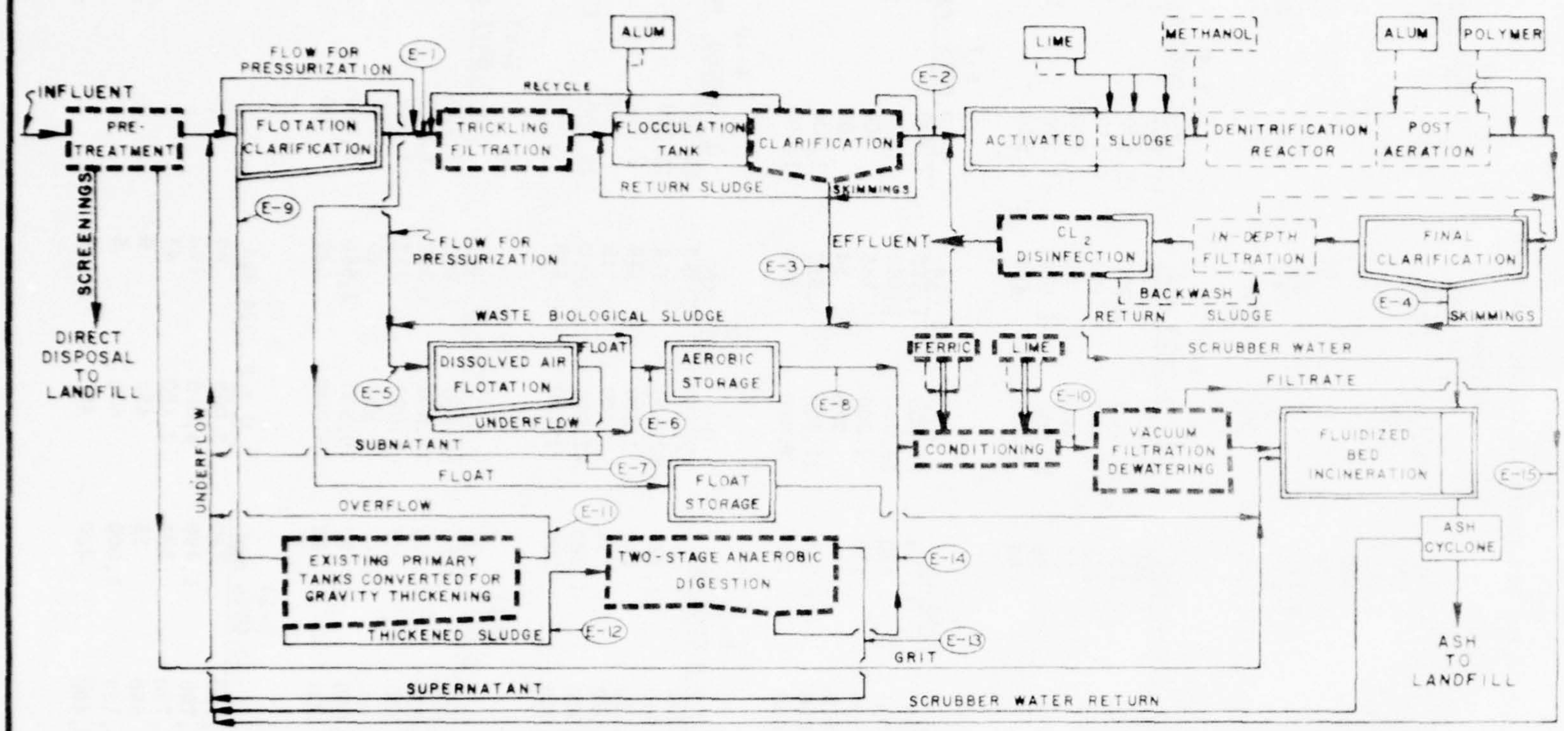
	E-2 Q = 1.0097 mgd		E-3 Q = 0.0074 mgd		E-4 Q = 0.0122 mgd	
BOD	160	1,380	12,600	780	8,300	840
COD	300	2,530	17,800	1,100	11,600	1,180
TKN	40	360	1,300	80	790	80
P	6	50	240	15	160	16
VSS	140	1,200	12,800	790	8,300	840
ISS	30	220	2,300	140	1,800	180

	E-5 Q = 0.0196 mgd		E-6 Q = 0.0059 mgd		E-7 Q = 0.0137 mgd	
BOD	10,000	1,630	29,700	1,460	1,500	170
COD	13,900	2,280	41,700	2,050	2,000	230
TKN	980	160	3,050	150	150	17
P	180	30	610	30	26	3
VSS	10,000	1,630	29,700	1,460	1,500	170
ISS	2,000	320	5,900	290	300	30

	E-8 Q = 0.0059 mgd		E-9 Q = 0.0077 mgd		E-10 Q = 0.0051 mgd	
BOD	24,400	1,200	31,100	2,000	45,400	1,930
COD	34,300	1,690	62,200	4,000	90,500	3,850
TKN	3,050	150	2,180	140	3,100	130
P	610	30	310	20	470	20
VSS	24,400	1,200	41,400	2,660	60,700	2,580
ISS	5,900	290	8,300	530	12,200	520
OIL & GR.			28,700	1,840	41,800	1,780

	E-11 Q = 0.0026 mgd		E-12 Q = 0.0013 mgd		E-13 Q = 0.0038 mgd	
BOD	2,800	60	3,700	40	23,300	740
COD	5,550	120	6,900	75	47,300	1,500
TKN	180	4	1,800	20	3,200	100
P	-	-	280	3	440	14
VSS	3,700	80	1,800	20	31,600	1,000
ISS	690	15	700	8	12,600	400

	E-14 Q = 0.0097 mgd		E-15 Q = 0.0072 mgd	
BOD	29,000	2,340	1,000	60
COD	50,200	4,060	2,000	120
TKN	3,200	260	720	43
P	570	46	200	12
VSS	34,100	2,760	300	20
ISS	9,900	800	80	5



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

- ▬ ▬ ▬ ..... EXISTING AND / OR UNDER DESIGN
- ═══ ..... LEVEL 1
- ─── ..... LEVEL 2
- — — — ..... LEVEL 3

LEVEL 2
RES. & IND.
Q_{INF} = 27 MGD

HAVENS AND EMERSON, LTD

FIGURE 6

COUNCIL BLUFFS-MOSQUITO CREEK PLANT SCHEMATIC

OMAHA DISTRICT
CORPS OF ENGINEERS

MASS DIAGRAM
LEVEL 2

RESIDENTIAL & INDUSTRIAL (COUNCIL BLUFFS)

	Influent		Effluent		E-1	
	Q = 1.0000 mgd		Q = 0.9931 mgd		Q = 1.0071 mgd	
Item	mg/l	#/Day	mg/l	#/Day	mg/l	#/Day
BOD	580	4,840	15	120	375	3,150
COD	1,050	8,750	55	460	630	5,300
TKN	60	500	2	17	43	360
P	8.5	70	1	8	8	70
VSS	500	4,170	10	90	210	1,770
ISS	100	840	5	40	40	360
OIL & GR.	240	2,040	30	260	25	210

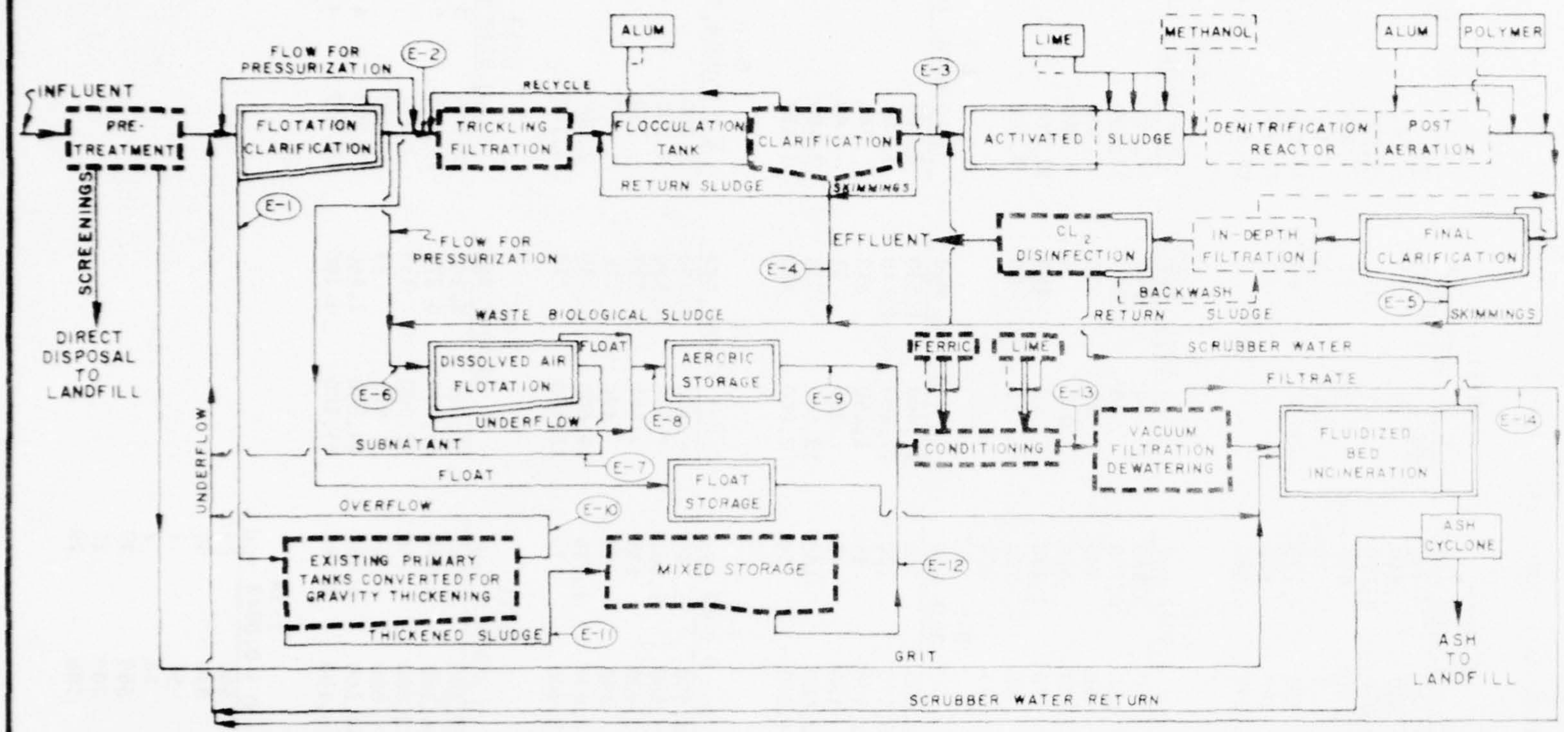
	E-2		E-3		E-4	
	Q = 0.9948 mgd		Q = 0.0123 mgd		Q = 0.0017 mgd	
BOD	40	360	15,300	1,570	11,300	160
COD	130	1,100	21,400	2,200	15,500	220
TKN	35	290	1,560	160	1,130	16
P	2	13	490	50	420	6
VSS	20	190	15,300	1,570	11,300	160
ISS	7	60	4,800	490	4,900	70

	E-5		E-6		E-7	
	Q = 0.0140 mgd		Q = 0.0066 mgd		Q =0.0073 mgd	
BOD	14,800	1,730	27,700	1,550	2,900	175
COD	20,700	2,420	39,000	2,180	3,900	240
TKN	1,460	170	2,800	155	300	18
P	510	60	970	54	100	6
VSS	14,800	1,730	27,700	1,550	2,900	175
ISS	4,800	560	9,000	500	1,000	60

	E-8		E-9		E-10	
	Q = 0.0066 mgd		Q = 0.0076 mgd		Q =0.0093 mgd	
BOD	22,900	1,280	31,200	1,980	25,500	1,980
COD	31,900	1,780	62,600	3,970	41,300	3,200
TKN	2,330	130	2,210	140	2,710	210
P	970	54	300	19	920	71
VSS	22,900	1,280	42,000	2,660	29,000	2,250
ISS	9,000	500	8,400	530	11,500	890

	E-11		E-12		E-13	
	Q = 0.0037 mgd		Q = 0.0039 mgd		Q = 0.0013 mgd	
BOD	1,900	60	59,300	1,930	3,700	40
COD	3,900	120	11,800	3,850	6,900	75
TKN	130	4	4,090	133	1,840	20
P	--	--	580	19	280	3
VSS	2,600	80	79,300	2,580	1,800	20
ISS	300	10	16,000	520	700	8

	E-14		E-15	
	Q = 0.0026 mgd		Q = 0.0024 mgd	
BOD	34,100	740	3,000	60
COD	68,700	1,490	6,000	120
TKN	4,750	103	2,150	43
P	690	15	450	9
VSS	46,100	1,000	400	8
ISS	18,400	400	400	8



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

- ....EXISTING AND / OR UNDER DESIGN
- ....LEVEL 1
- ....LEVEL 2
- ....LEVEL 3

LEVEL 2
RES. & IND. & H_2O WASTES
Q_{INF} = 27MGD

HAVENS AND EMERSON, LTD

FIGURE 7

COUNCIL BLUFFS-MOSQUITO CREEK PLANT SCHEMATIC

OMAHA DISTRICT
CORPS OF ENGINEERS

MASS DIAGRAM

LEVEL

RESIDENTIAL & INDUSTRIAL & H_2O WASTES (MOSQUITO)

Item	Influent Q = 1.0000 mgd mg/l	#/Day	Effluent Q = 0.9897 mgd mg/l	#/Day	E-1 Q = 0.0115 mgd mg/l	#/Day
BOD	580	4,840	15	120	23,000	2,210
COD	1,050	8,750	45	375	45,900	4,400
TKN	60	500	2	17	1,560	150
P	8.5	70	0.4	3	470	45
VSS	500	4,170	10	90	30,800	2,950
ISS	100	840	4	30	45,000	4,310
OIL & GR.	240	2,040			19,200	1,840

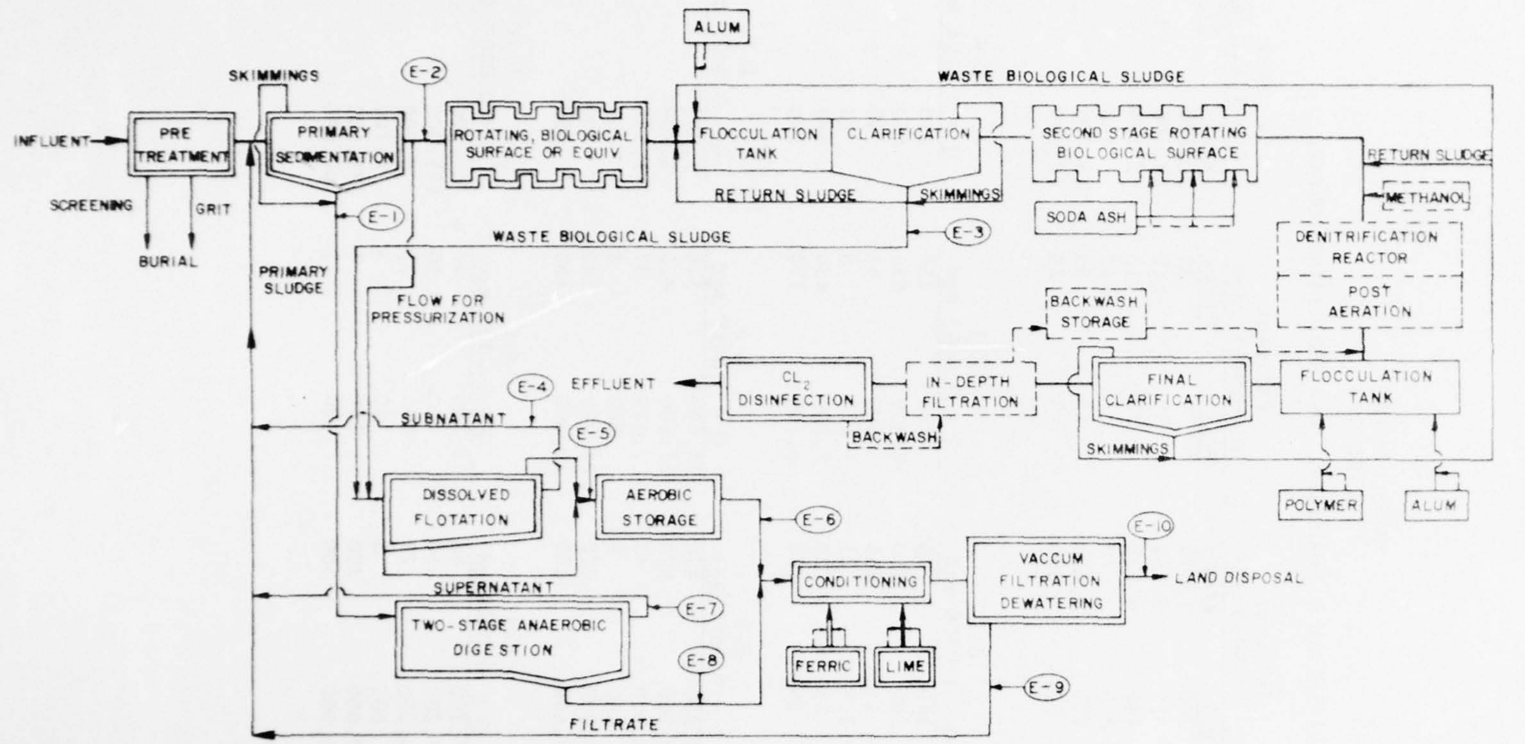
	E-2 Q = 1.0042 mgd		E-3 Q = 0.9913 mgd		E-4 Q = 0.0129 mgd	
BOD	340	2,840	40	325	12,700	1,370
COD	560	4,700	130	1,060	17,800	1,920
TKN	43	360	28	230	1,300	140
P	39	330	0.5	4	280	30
VSS	170	1,460	20	160	12,700	1,370
ISS	90	790	10	90	7,300	790
OIL & GR.	25	210				

	E-5 Q = 0.0016 mgd		E-6 Q = 0.0146 mgd		E-7 Q = 0.0076 mgd	
BOD	12,000	160	12,600	1,530	2,400	150
COD	16,500	220	17,600	2,140	3,500	220
TKN	1,200	16	1,250	152	240	15
P	150	2	250	31	50	3
VSS	12,000	160	12,600	1,530	2,400	150
ISS	4,500	60	7,000	850	1,300	80

	E-8 Q = 0.0069 mgd		E-9 Q = 0.0069 mgd		E-10 Q = 0.0038 mgd	
BOD	24,000	1,380	19,600	1,130	2,200	70
COD	33,500	1,930	27,500	1,580	4,100	130
TKN	2,400	138	1,960	113	130	4
P	490	28	490	28	60	2
VSS	24,000	1,380	19,600	1,130	2,800	90
ISS	13,400	770	13,400	770	4,100	130

	E-11 Q = 0.0077 mgd		E-12 Q = 0.0077 mgd		E-13 Q = 0.0146 mgd	
BOD	33,300	2,140	33,300	2,140	26,900	3,270
COD	66,500	4,270	66,500	4,270	48,000	5,850
TKN	2,300	148	2,300	148	2,140	260
P	690	44	690	44	590	72
VSS	44,500	2,860	44,500	2,860	32,900	4,000
ISS	65,100	4,180	65,100	4,180	40,700	4,950

	E-14 Q = 0.0043 mgd	
[illegible]	560	20
[illegible]	840	30
[illegible]	56	2
[illegible]	56	2
[illegible]	560	20
[illegible]	700	25
[illegible]	700	25



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

LEVEL I .... ═══
LEVEL II .... ───
LEVEL III .... - - - -

LEVEL 1
RES. & IND.
>2 MGD

FIGURE 8
MINOR URBAN
PLANT SCHEMATIC*

OMAHA DISTRICT
CORPS OF ENGINEERS

HAVENS AND EMERSON, LTD

* (FLOW ≥ 2mgd, Excluding ELKHORN, BLAIR And BELLEVUE)

MASS DIAGRAM
LEVEL 1

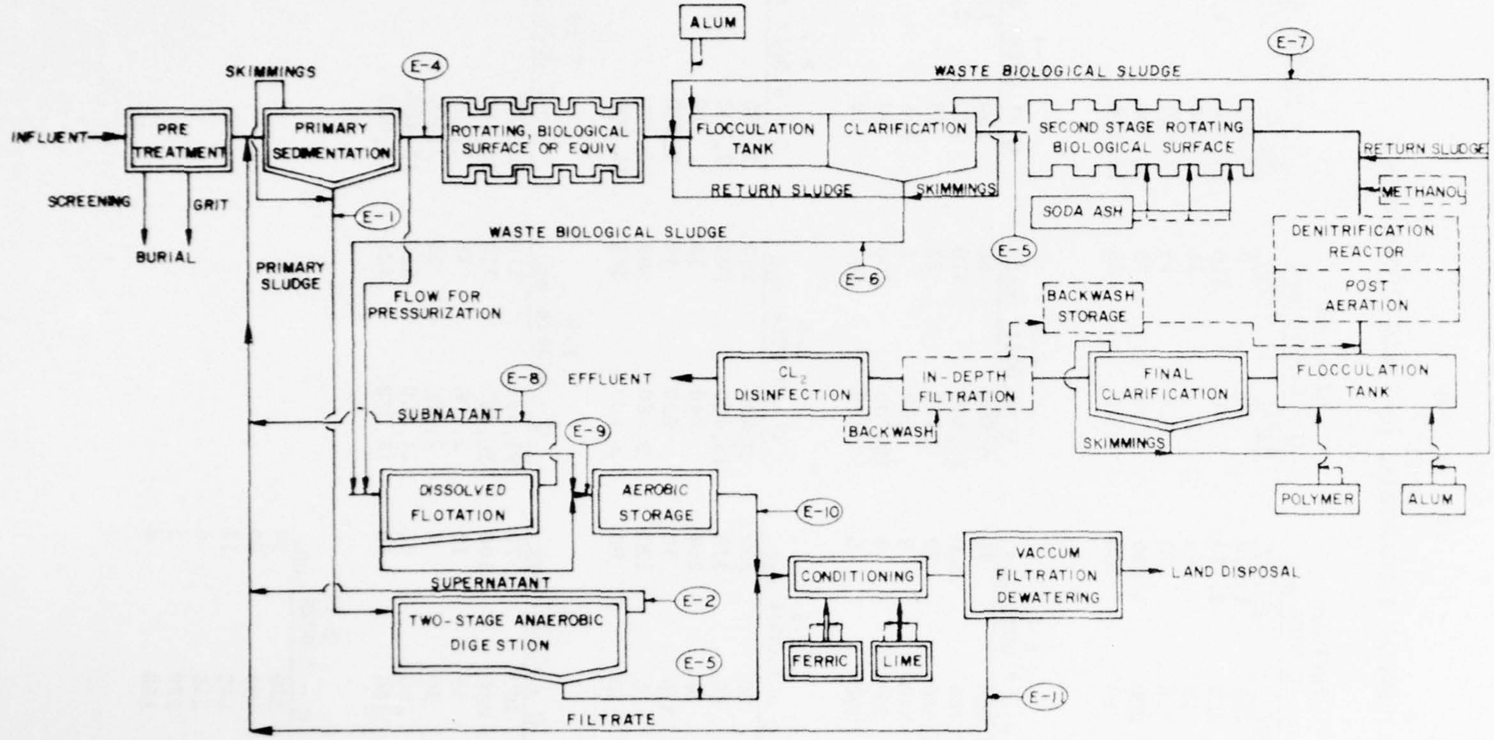
RESIDENTIAL & INDUSTRIAL [Q>2 MGD] (MINOR-URBAN)

	Influent		Effluent		E-1	
	Q = 1.0000 mgd		Q =0.9093 mgd		Q = 0.0031 mgd	
Item	mg/l	#/Day	mg/l	#/Day	mg/l	#/Day
BOD	230	1,920	30	230	32,100	830
COD	450	3,750	85	640	68,100	1,760
TKN	485	4,050	28	210	2,100	54
P	8.5	70	7	53	460	12
VSS	200	1,670	20	150	38,700	1,000
ISS	60	500	5	40	12,000	310

	E-2		E-3		E-4	
	Q = 1.0205 mgd		Q = 0.0062 mgd		Q = 0.0194 mgd	
BOD	140	1,180	770	450	280	45
COD	260	2,210	12,200	630	430	70
TKN	33	285	890	46	50	8
P	2.5	21	170	9	12	2
VSS	85	720	8,700	450	370	60
ISS	26	220	3,300	170	120	20

	E-5		E-6		E-7	
	Q = 0.0017 mgd		Q = 0.0017 mgd		Q = 0.0021 mgd	
BOD	28,900	410	24,000	340	1,700	30
COD	40,200	570	33,100	470	5,700	100
TKN	2,960	42	2,610	37	1,540	27
P	560	8	560	8	400	7
VSS	28,900	410	24,000	340	300	5
ISS	10,600	150	10,600	150	300	5

	E-8		E-9		E-10	
	Q = 0.0010mgd		Q = 0.0020 mgd		Q = 0.0007 mgd	
BOD	7,200	60	1,200	20	65,100	380
COD	37,200	310	3,000	50	125,000	730
TKN	3,200	27	780	13	8,700	51
P	600	5	180	3	1,700	10
VSS	22,800	190	180	3	89,100	520
ISS	36,000	300	120	2	90,800	530



NOTE: UNIT PROCESS AND CHEMICAL ADDITION DESIGNATION

LEVEL I ════
LEVEL II ────
LEVEL III - - - -

LEVEL 2
RES. & IND.
> 2 MGD

HAVENS AND EMERSON, LTD.

FIGURE 9
MINOR URBAN PLANT SCHEMATIC*
OMAHA DISTRICT
CORPS OF ENGINEERS

* (FLOW ≥ 2mgd, Excluding ELKHORN, BLAIR And BELLEVUE)

MASS DIAGRAM
LEVEL 2
RESIDENTIAL & INDUSTRIAL [Q>2 MGD] (MINOR URBAN)

	Influent Q = 1.0000 mgd		Effluent Q = 0.9990 mgd		E-1 Q = 0.0032 mgd	
Item	mg/1	#/Day	mg/1	#/Day	mg/1	#/Day
BOD	230	1,920	10	70	30,000	800
COD	450	3,750	40	310	64,800	1,730
TKN	35	290	2.5	21	1,950	52
P	8.5	70	1.8	15	560	15
VSS	200	1,690	5	40	36,300	970
ISS	60	500	10	80	13,100	350
OIL & GR.						

	E-2 Q = 0.0021 mgd		E-3 Q =0.0011 mgd		E-4 Q =1.0068 mgd	
BOD	2,000	35	6,500	60	150	1,230
COD	5,700	100	33,800	310	270	2,260
TKN	1,660	29	2,500	23	35	290
P	510	9	650	6	8.8	74
VSS	230	4	20,700	190	90	750
ISS	290	5	37,100	340	20	200

	E-5 Q = 1.0004 mgd		E-6 Q = 0.0064 mgd		E-7 Q = 0.0014 mgd	
BOD	20	200	9,400	500	5,100	60
COD	80	670	13,100	700	7,700	90
TKN	28	234	940	50	510	6
P	3.6	30	820	44	1,300	15
VSS	15	120	9,400	500	5,100	60
ISS	10	90	6,500	345	11,100	130

	E-8 Q = 0.0274 mgd		E-9 Q = 0.0028 mgd		E-10 Q = 0.0028 mgd	
BOD	300	70	21,800	510	18,400	430
COD	440	100	30,400	710	26,100	610
TKN	48	11	2,100	50	2,100	50
P	30	7	2,300	53	2,300	53
VSS	260	60	21,800	510	18,400	430
ISS	180	40	18,000	420	18,000	420

	E-11 Q = 0.0029 mgd	
BOD	830	20
COD	2,100	50
TKN	540	13
P	250	6
VSS	120	3
ISS	160	4

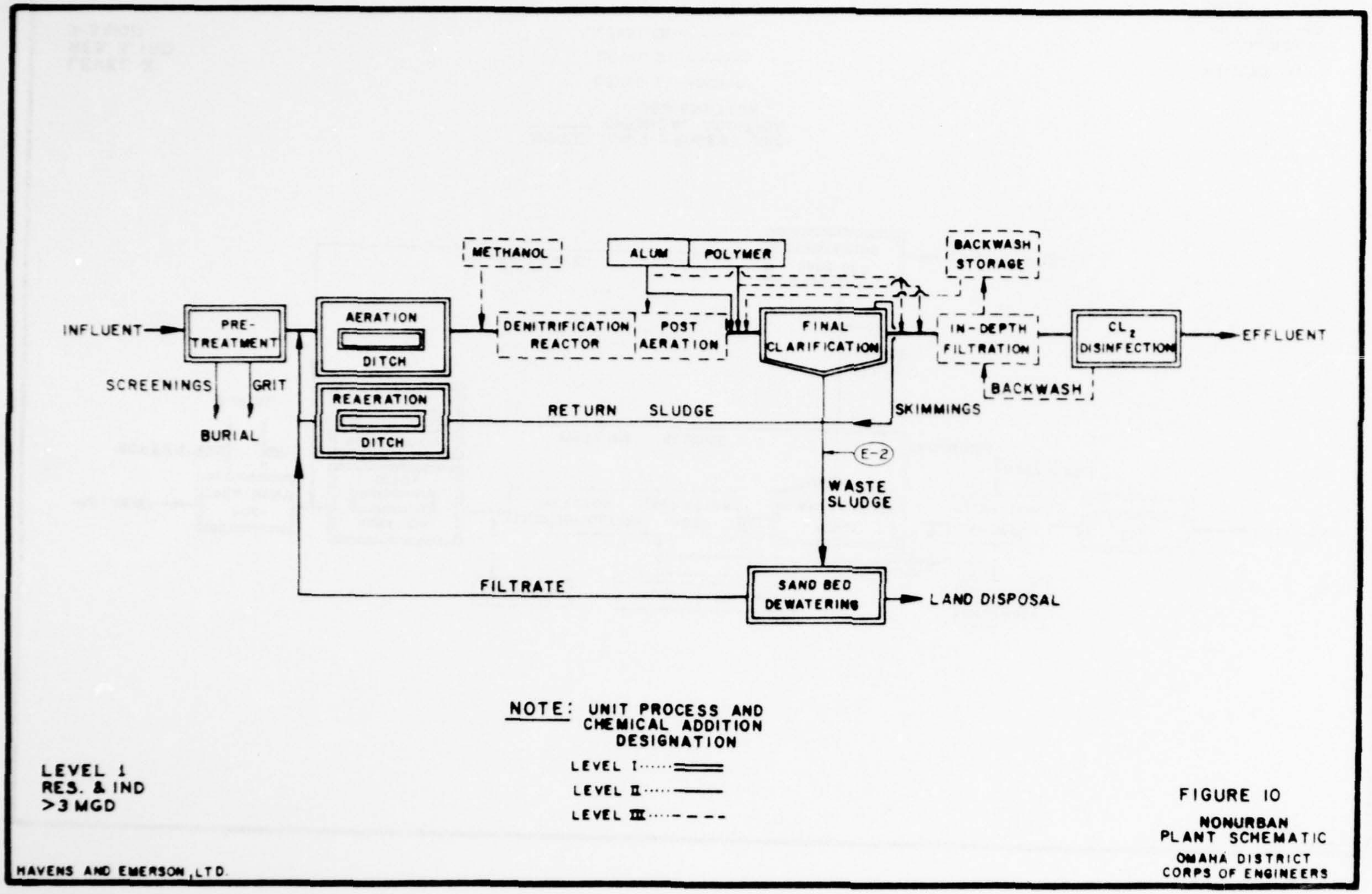


FIGURE 10

NONURBAN PLANT SCHEMATIC

OMAHA DISTRICT
CORPS OF ENGINEERS

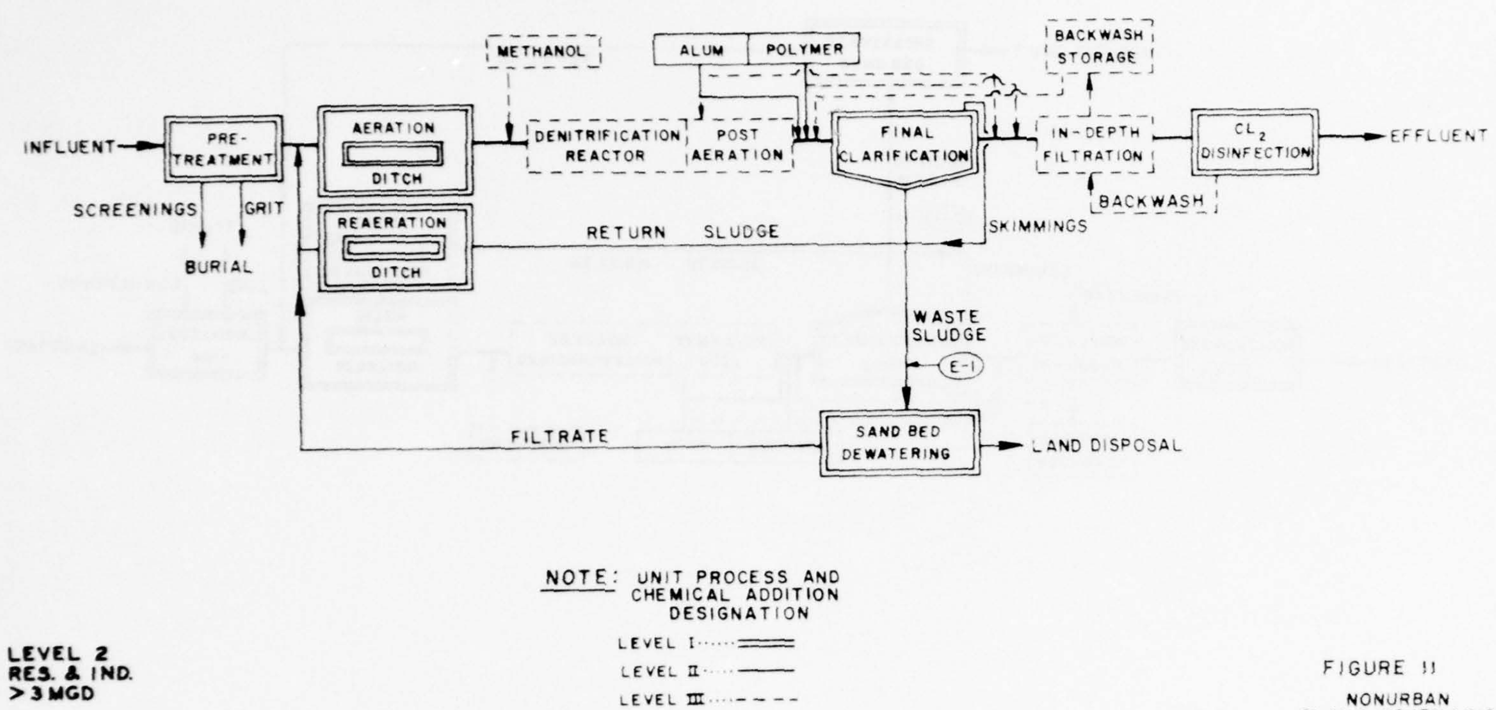


FIGURE 11

NONURBAN PLANT SCHEMATIC

OMAHA DISTRICT
CORPS OF ENGINEERS

HAVENS AND EMERSON, LTD.

MASS DIAGRAM
LEVEL 1
RESIDENTIAL & INDUSTRIAL (NON-URBAN)

Item	Influent Q = 1.0000 mgd		Effluent Q = 0.9853 mgd		E-1 Q = 0.0147 mgd	
	mg/1	#/Day	mg/1	#/Day	mg/1	#/Day
BOD	270	2,250	10	60	1,500	180
COD	530	4,420	60	460	8,400	1,030
TKN	40	342	18	150	600	74
P	10	83	8	70	120	15
VSS	260	2,170	15	120	6,000	740
ISS	70	580	10	80	4,000	490

MASS DIAGRAM
LEVEL 2
RESIDENTIAL & INDUSTRIAL (NON-URBAN)

Item	Influent Q = 1.0000 mgd		Effluent Q = 0.9877 mgd		E-1 Q = 0.0123 mgd	
	mg/1	#/Day	mg/1	#/Day	mg/1	#/Day
BOD	270	2,250	5	40	1,950	200
COD	530	4,420	45	370	11,000	1,120
TKN	41	342	17.3	142	780	80
P	10	83	1.2	10	715	73
VSS	260	2,170	8	60	7,800	800
ISS	70	580	8	60	8,200	840

APPENDIX C

PHASE I ALTERNATIVE PLATES

LEGEND

PLANT	MAJOR URBAN	MINOR URBAN
REATMENT AND DISCHARGE TO DESIGNATED GOAL	T	T
CONDARY TREATMENT PRIOR TO LAND APPLICATION	S	S

STORMWATER

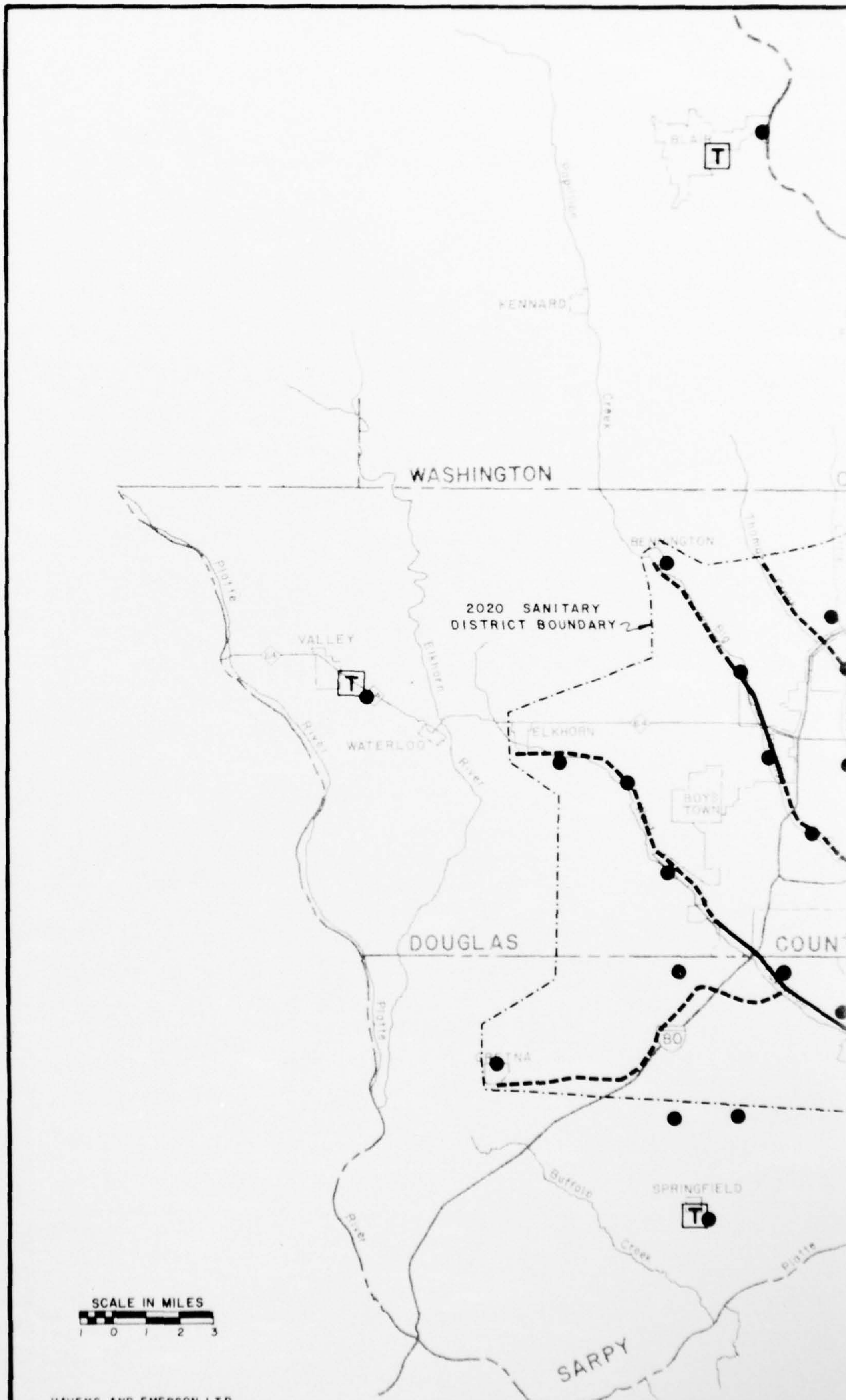
REATMENT AND DISCHARGE TO DESIGNATED GOAL ●

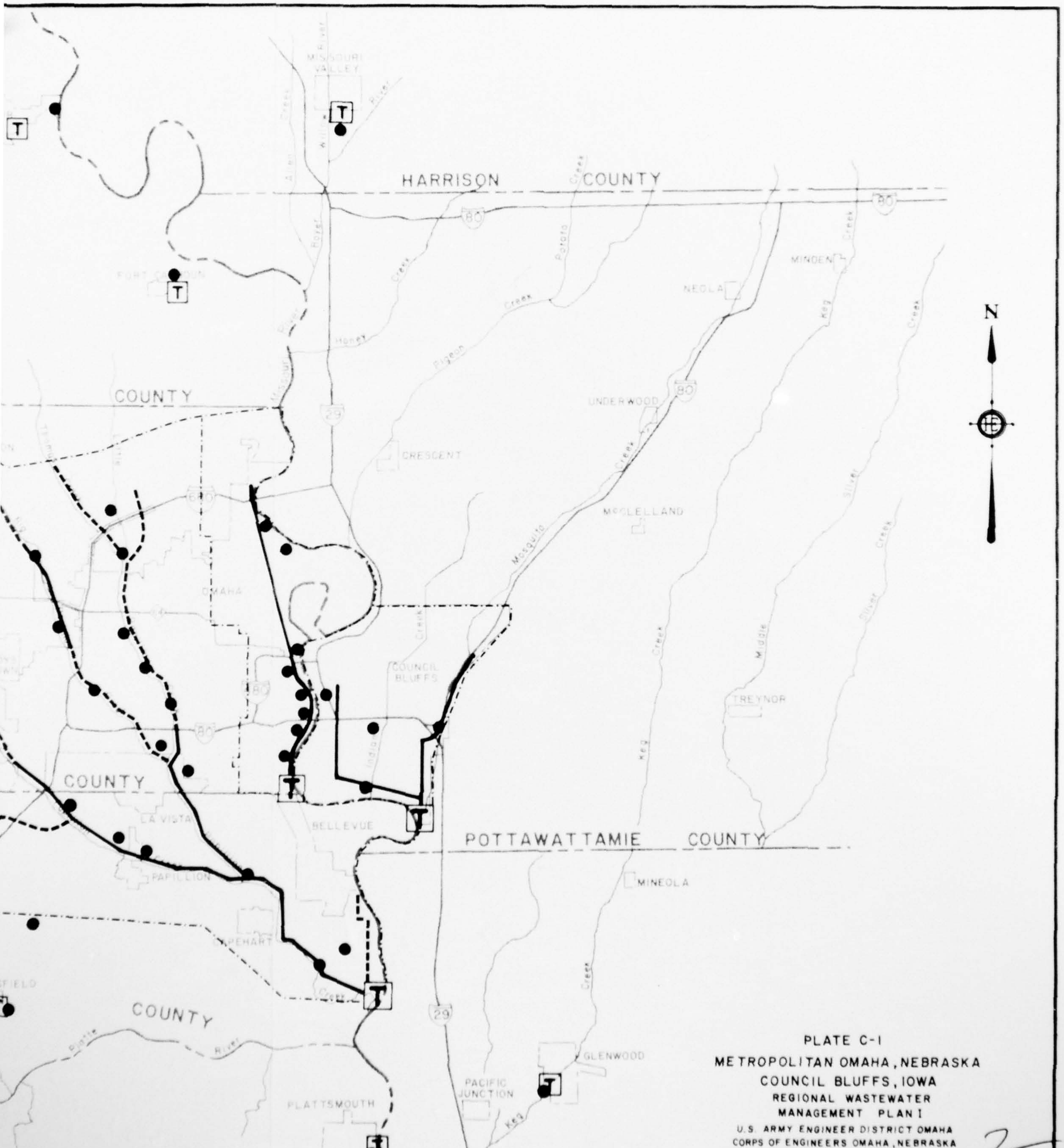
STORAGE AND DISCHARGE D TRANSMISSION FACILITY ○

TRANSMISSION FACILITIES

EXISTING ————

PROPOSED - - - - -





MISSOURI VALLEY
HARRISON COUNTY
MINDEN
NEOLA
UNDERWOOD
CRESCENT
McCLELLAND
COUNTY
OMAHA
COUNCIL BLUFFS
TREYNOR
COUNTY
LA VISTA
BELLEVUE
POTTAWATTAMIE COUNTY
PAPILLION
MINEOLA
CAPEHART
COUNTY
GLENWOOD
PACIFIC JUNCTION
PLATTSMOUTH
N
PLATE C-1
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN I
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

LEGEND

	MAJOR URBAN	MINOR URBAN
PLANT		
REATMENT AND DISCHARGE TO DESIGNATED GOAL	T	T
ONDARY TREATMENT PRIOR TO LAND APPLICATION	S	S

STORMWATER

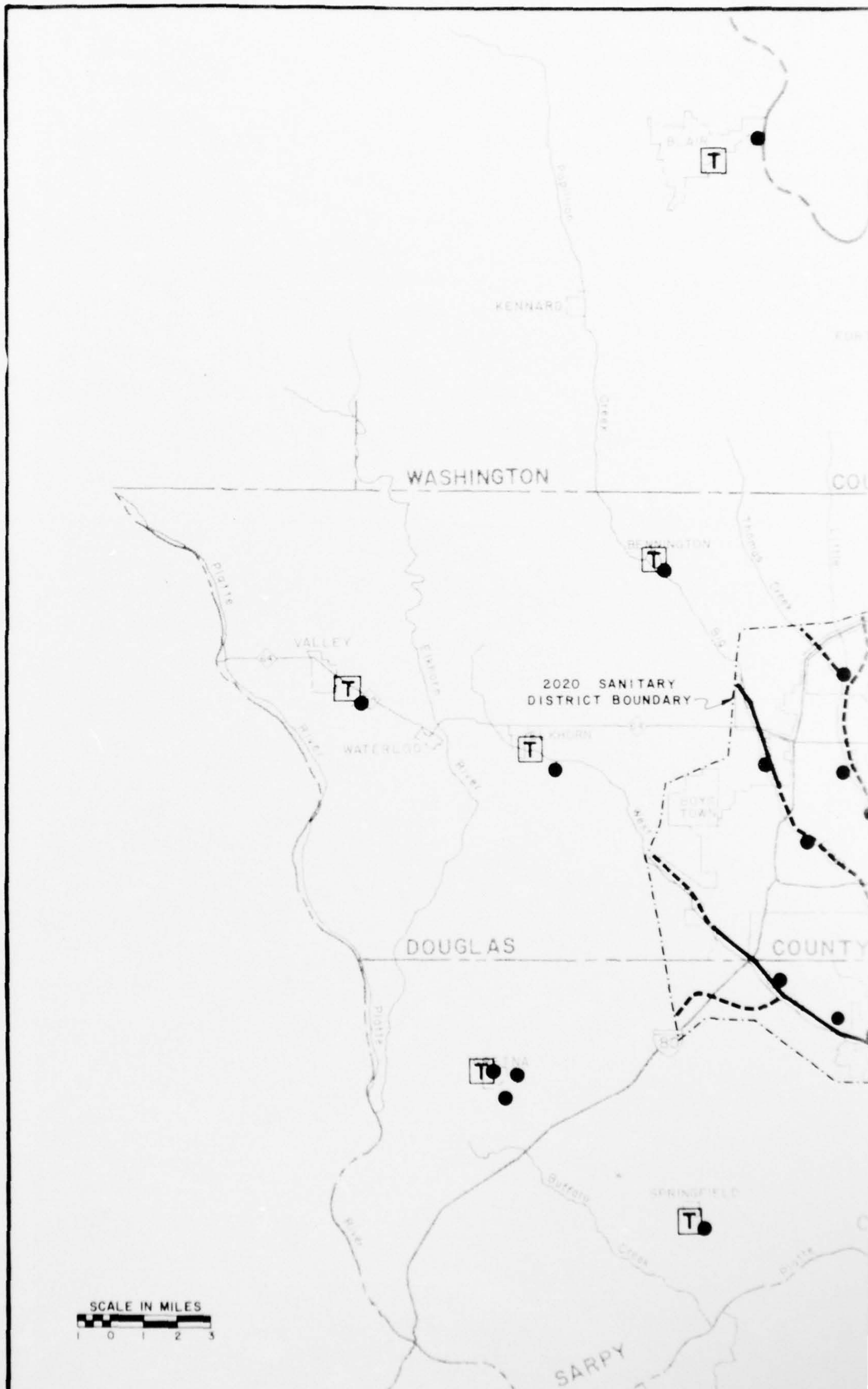
EATMENT AND DISCHARGE TO DESIGNATED GOAL ●

STORAGE AND DISCHARGE TRANSMISSION FACILITY ○

TRANSMISSION FACILITIES

EXISTING ———

PROPOSED - - - - -



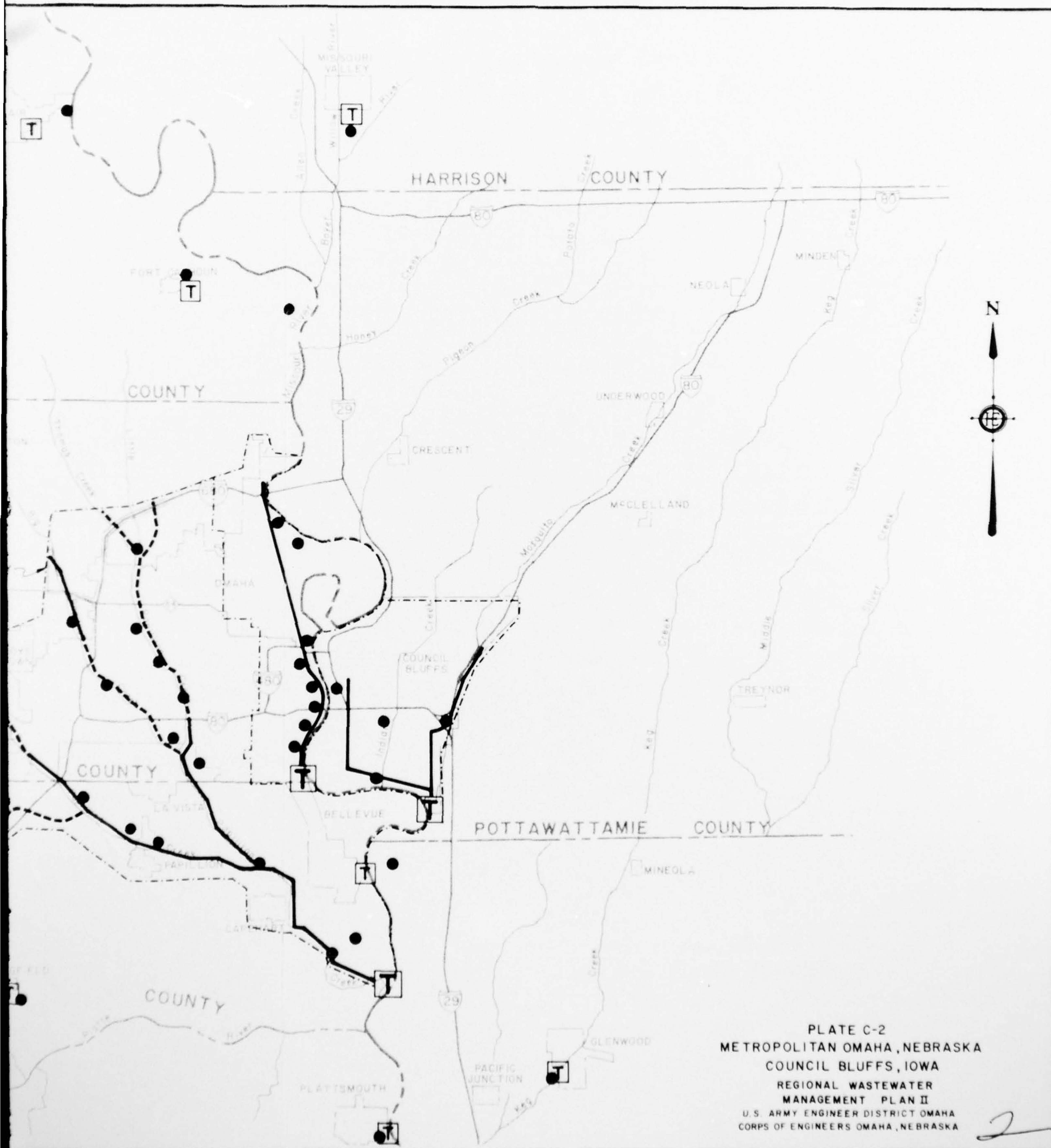


PLATE C-2
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN II
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

LEGEND

PLANT	MAJOR URBAN	MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL	T	T
SECONDARY TREATMENT PRIOR TO LAND APPLICATION	S	S

STORMWATER

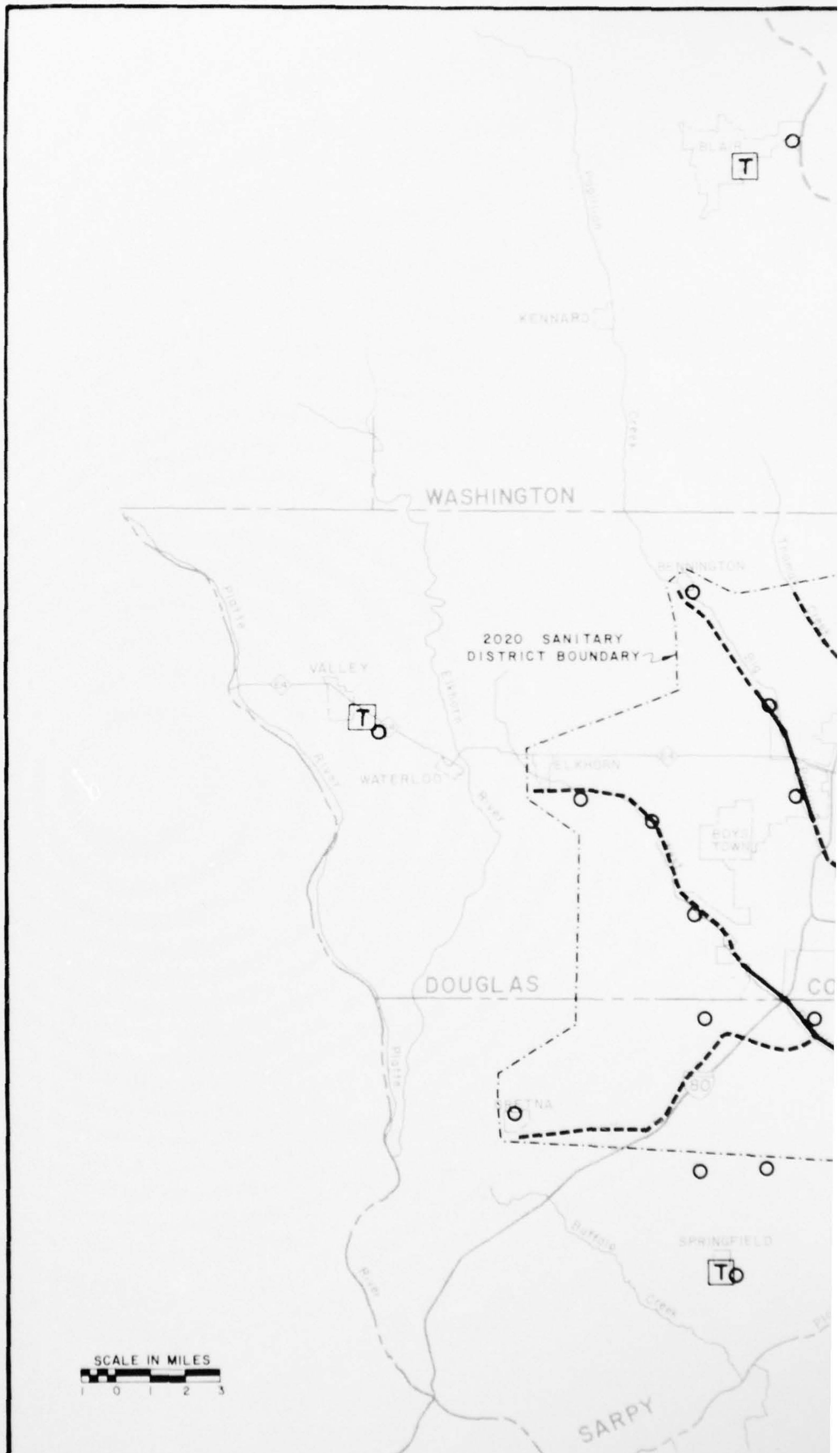
TREATMENT AND DISCHARGE TO DESIGNATED GOAL ●

STORAGE AND DISCHARGE TO TRANSMISSION FACILITY ○

TRANSMISSION FACILITIES

EXISTING ————

PROPOSED - - - - - - -



AD-A041 935 ARMY ENGINEER DISTRICT OMAHA NEBR F/G 8/6

WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY. VOLUME V. SU--ETC(U)

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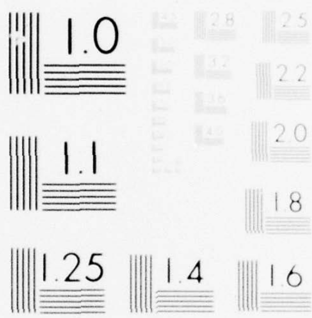


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

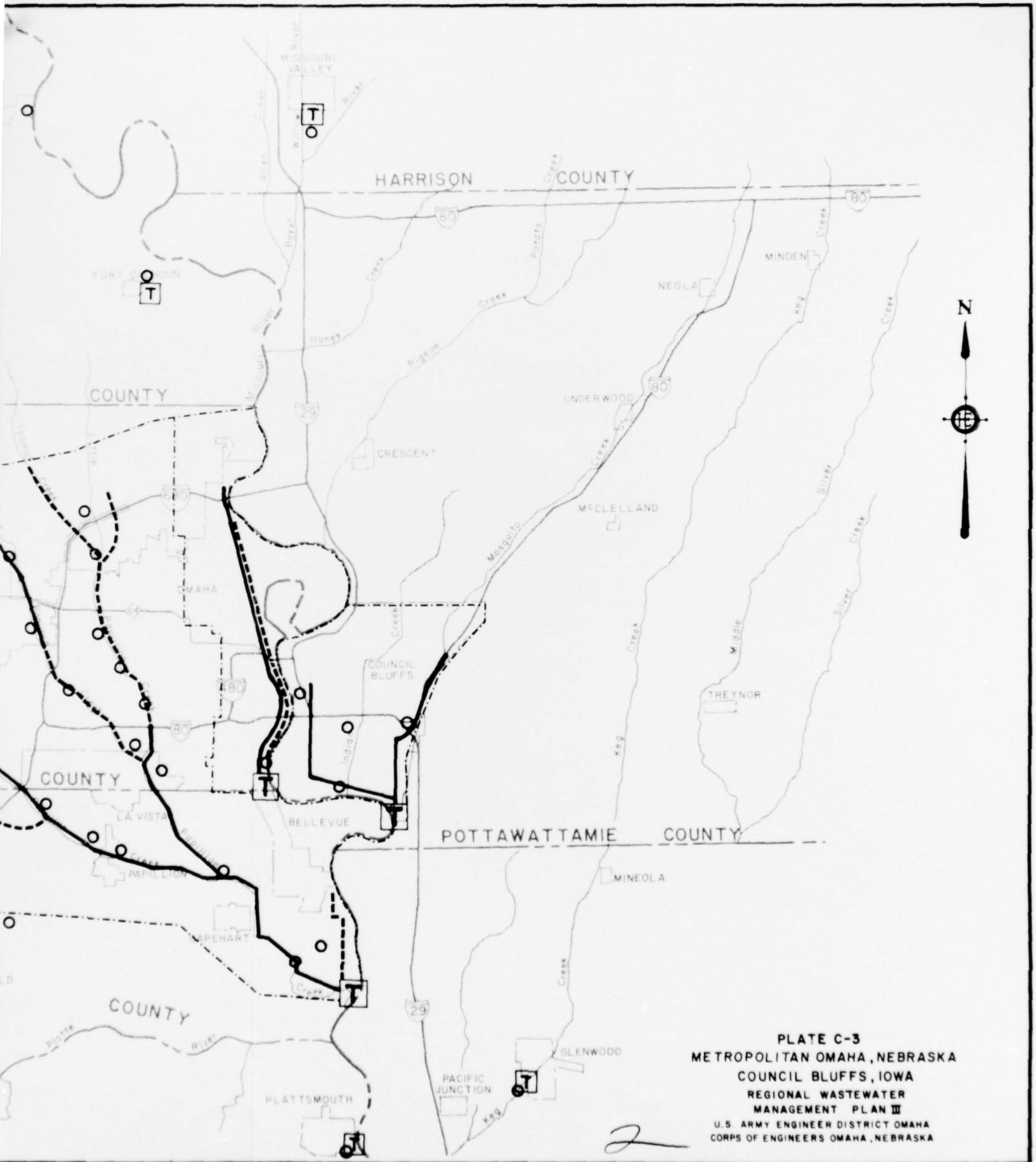


PLATE C-3
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN III
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

LEGEND

PLANT

	MAJOR URBAN	MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL	T	T
SECONDARY TREATMENT PRIOR TO LAND APPLICATION	S	S

STORMWATER

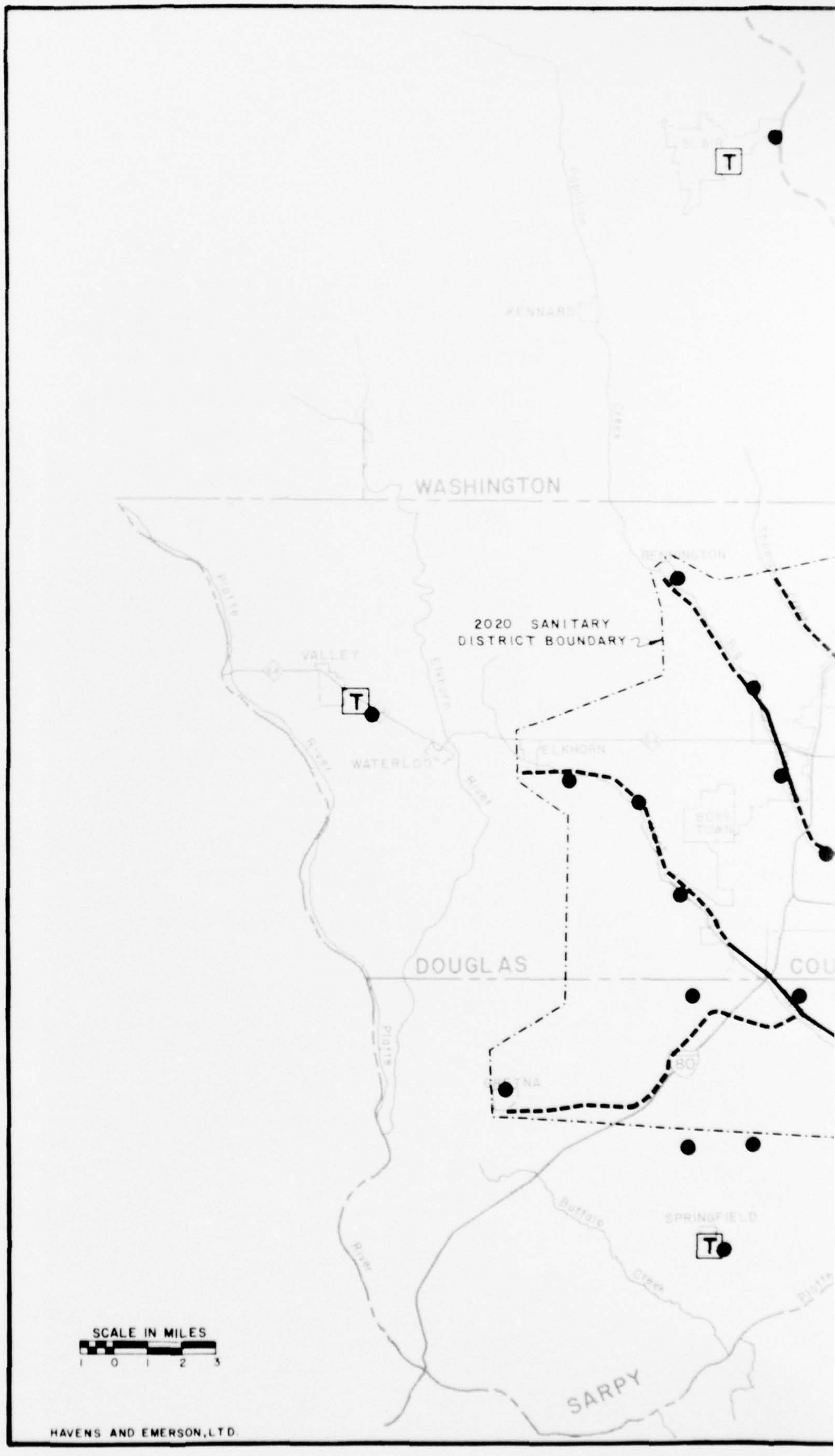
TREATMENT AND DISCHARGE TO DESIGNATED GOAL ●

STORAGE AND DISCHARGE TO TRANSMISSION FACILITY ○

TRANSMISSION FACILITIES

EXISTING ———

PROPOSED - - - - -



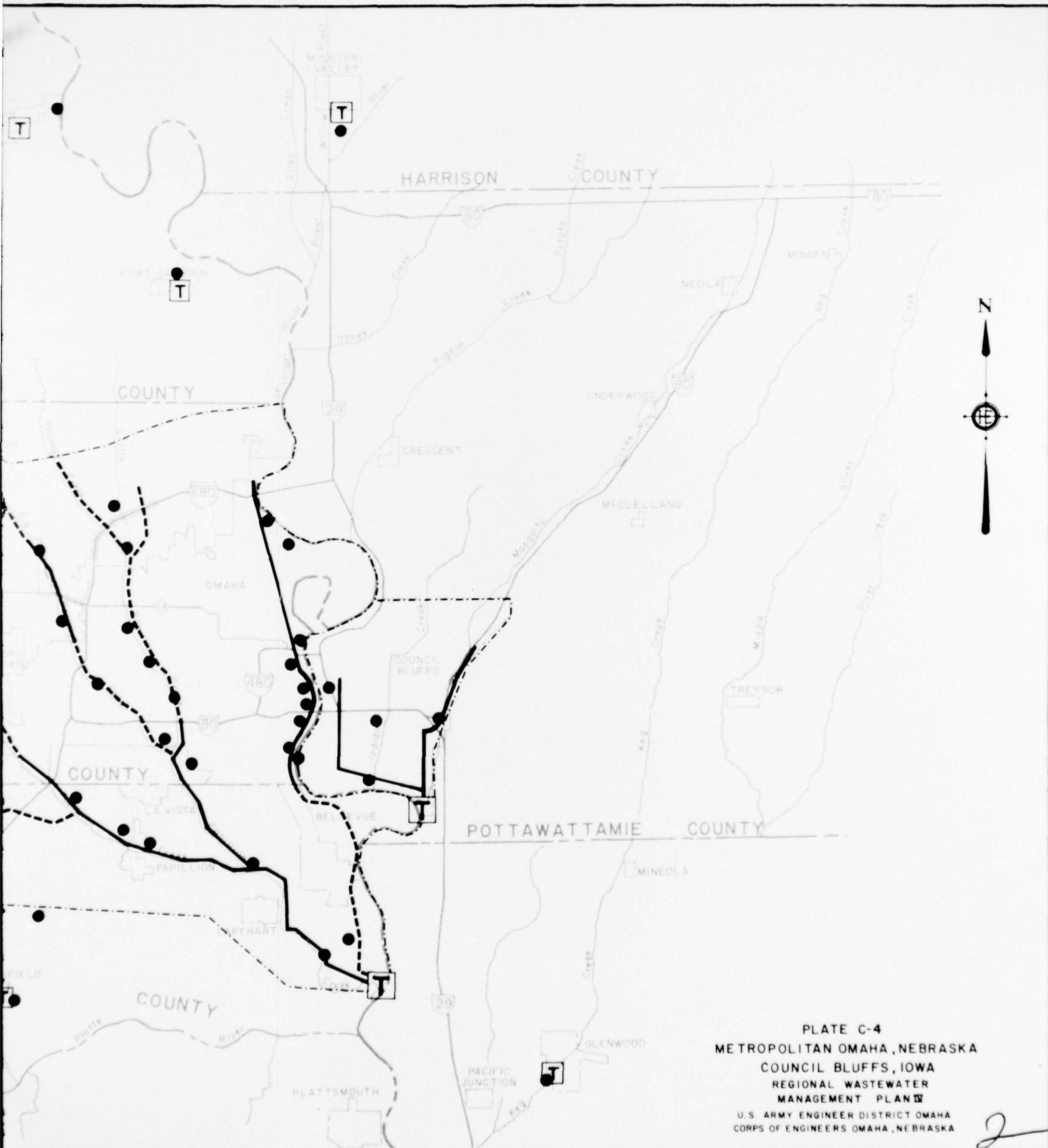


PLATE C-4
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN IV
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

LEGEND

	MAJOR URBAN	MINOR URBAN
PLANT		
TREATMENT AND DISCHARGE TO DESIGNATED GOAL	T	T
SECONDARY TREATMENT PRIOR TO LAND APPLICATION	S	S

STORMWATER

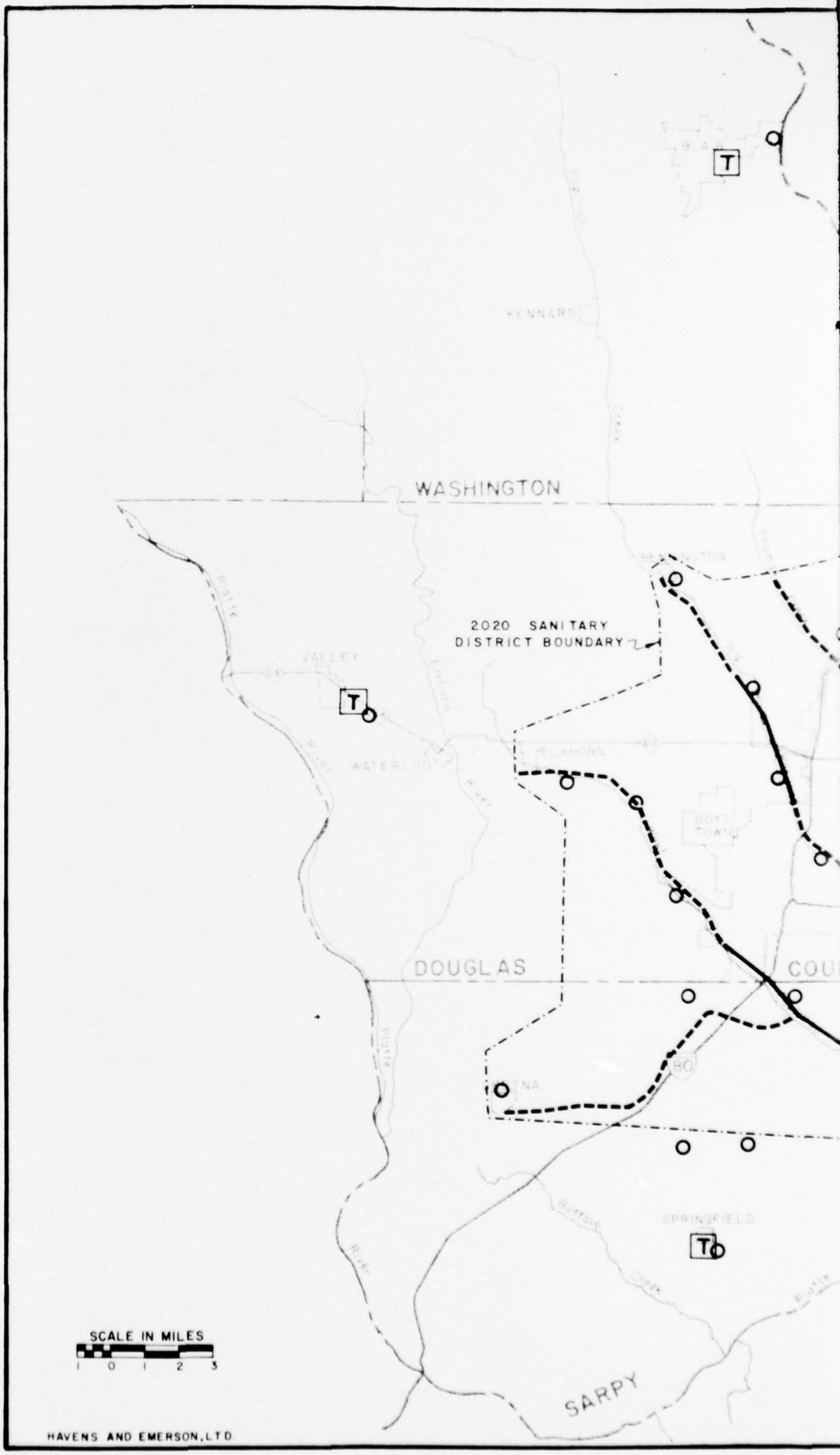
TREATMENT AND DISCHARGE TO DESIGNATED GOAL ●

STORAGE AND DISCHARGE TO TRANSMISSION FACILITY ○

TRANSMISSION FACILITIES

EXISTING ————

PROPOSED - - - - -



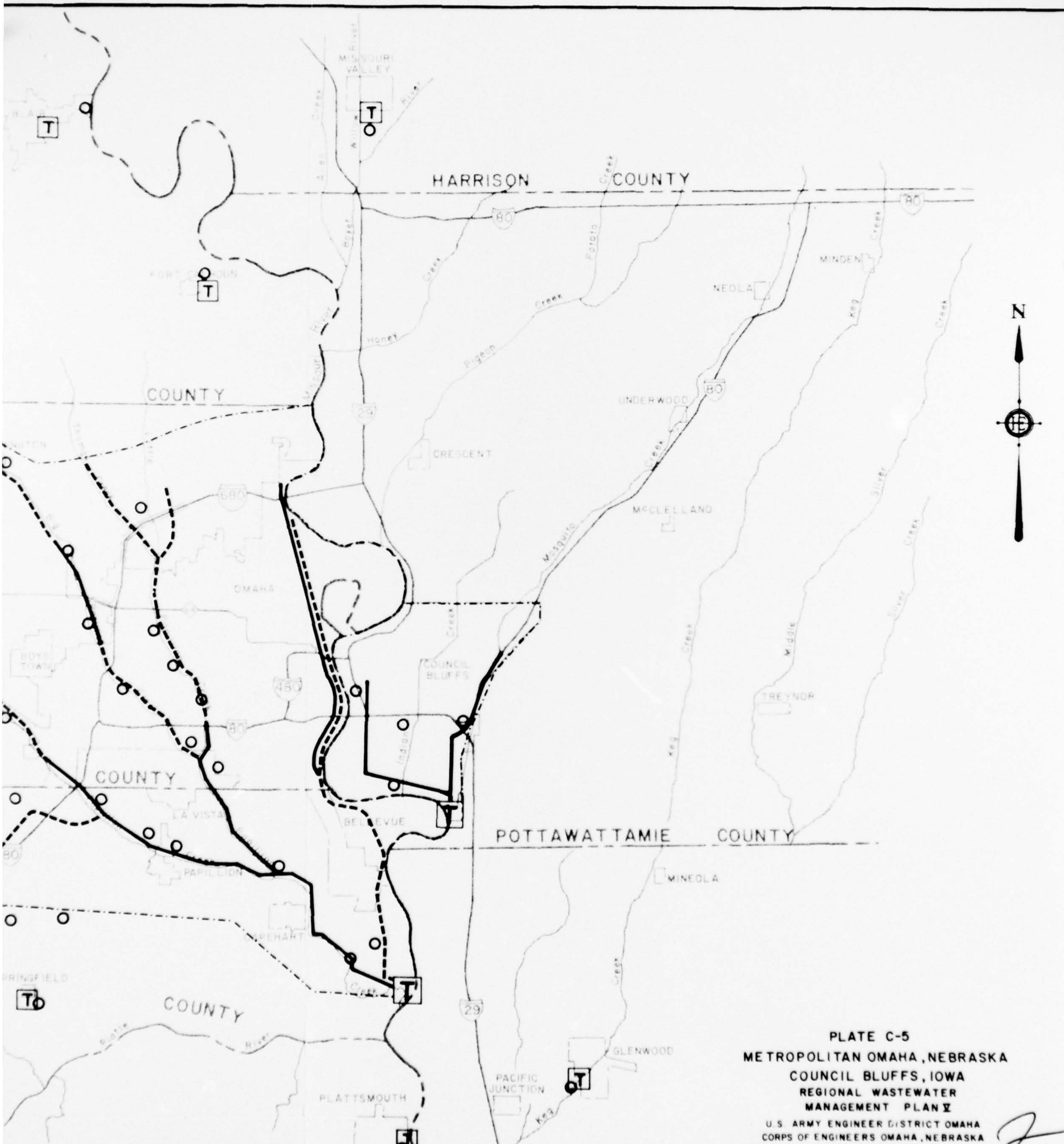
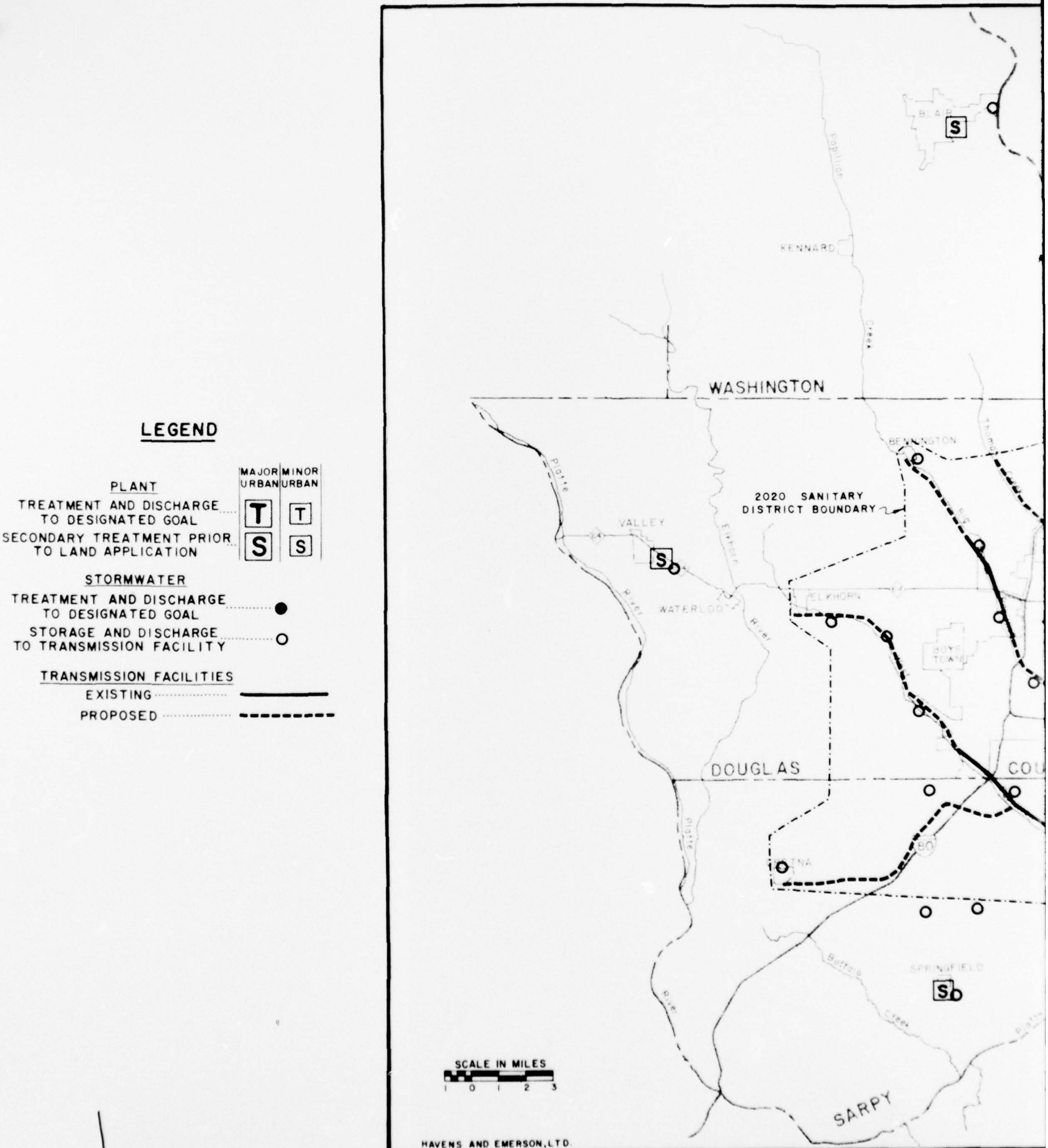
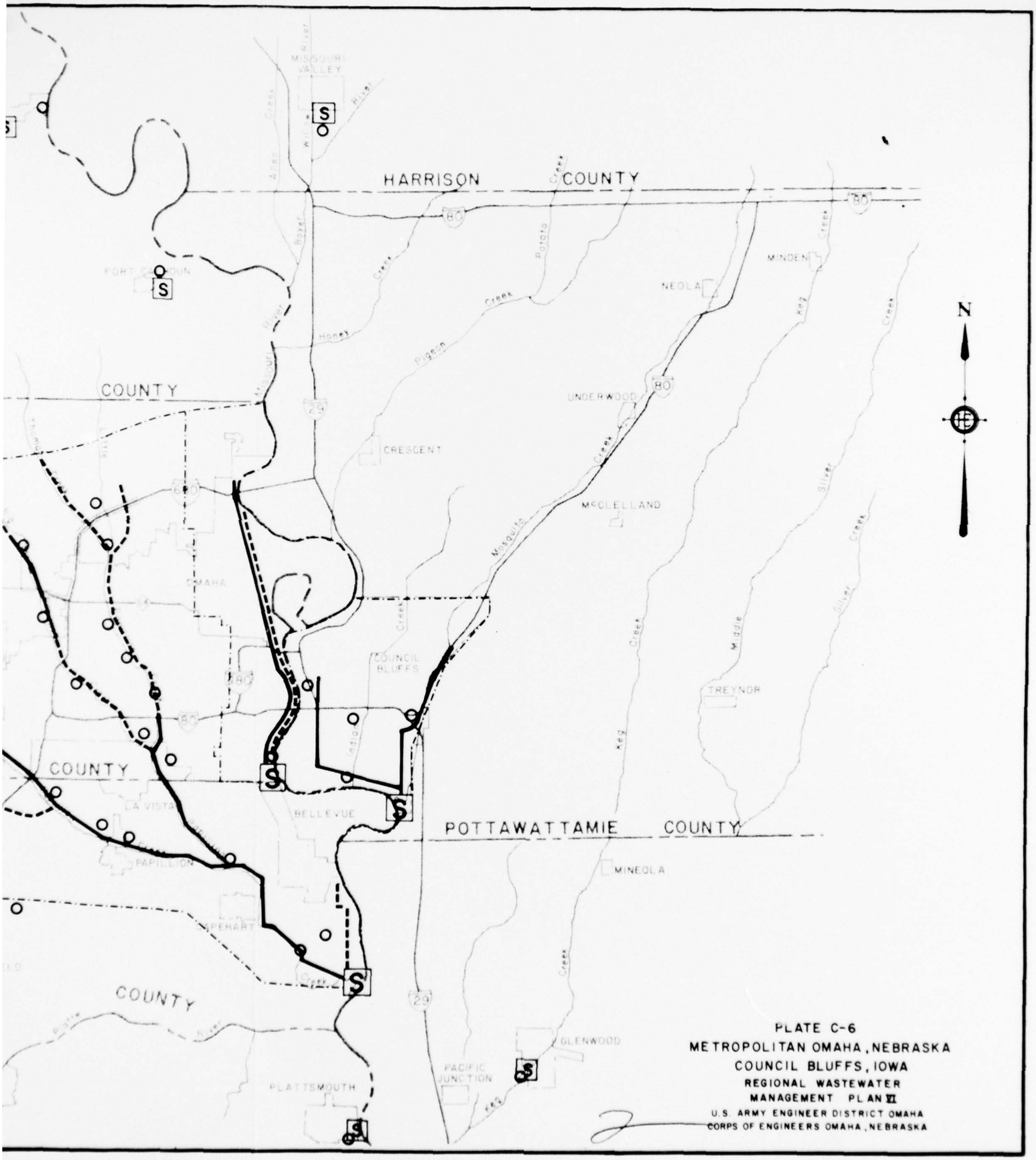


PLATE C-5
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN V
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

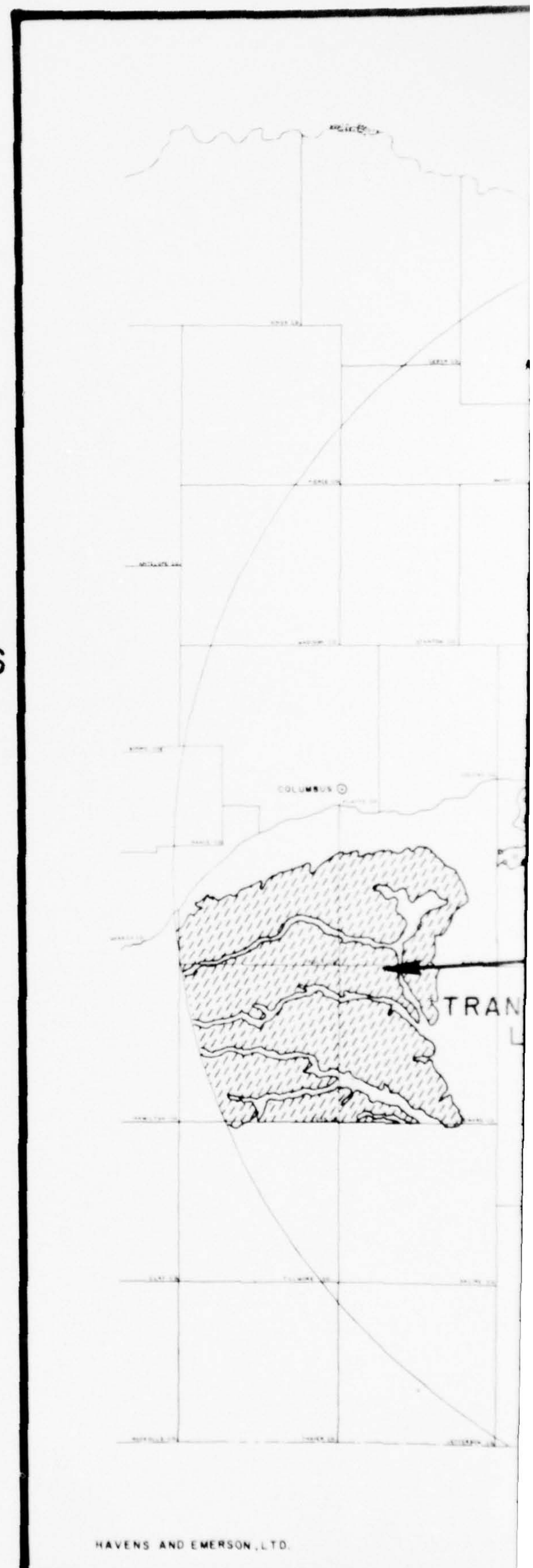

LEGEND
PLANT
MAJOR URBAN
MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
T
T
SECONDARY TREATMENT PRIOR TO LAND APPLICATION
S
S
STORMWATER
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
STORAGE AND DISCHARGE TO TRANSMISSION FACILITY
TRANSMISSION FACILITIES
EXISTING
PROPOSED
BLAIR
KENNARD
WASHINGTON
BENNINGTON
2020 SANITARY DISTRICT BOUNDARY
VALLEY
WATERLOO
ELKHORN
BOYS TOWN
DOUGLAS
COU
SPRINGFIELD
SARPY
Platte River
Elkhorn River
Papillion Creek
Buffalo Creek
SCALE IN MILES
1 0 1 2 3
HAVENS AND EMERSON, LTD.


HARRISON COUNTY
MISSOURI VALLEY
FORT CALHOUN
NEOLA
MINDEN
UNDERWOOD
CRESCENT
McCLELLAND
OMAHA
COUNCIL BLUFFS
TREYNOR
LA VISTA
BELLEVUE
PAPILLION
POTTAWATTAMIE COUNTY
MINEOLA
GLENWOOD
PACIFIC JUNCTION
PLATTSMOUTH
COUNTY
COUNTY
COUNTY
N
PLATE C-6
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN VI
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

LEGEND

LAND TREATMENT PRIORITY OF SITES

- Nº1 23 AND 22 - Nebraska
- Nº2 29 AND 30 - Nebraska
- Nº3 21, 22 AND 26 - Nebraska
- Nº4 26 AND 29 - Iowa
- Nº5 6 AND 14 - Iowa
- Nº6 12, 18, 33 AND 34 - Iowa



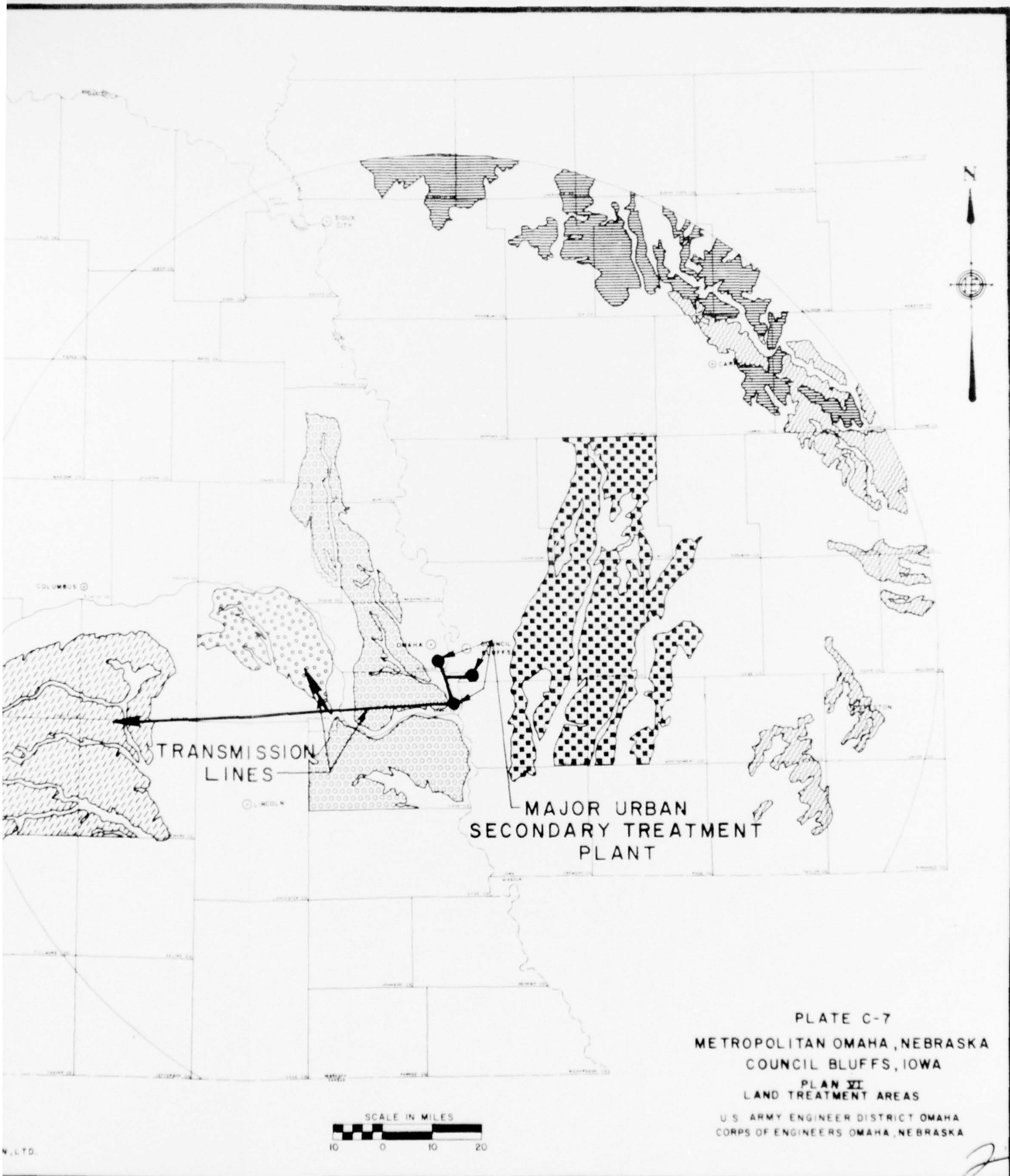


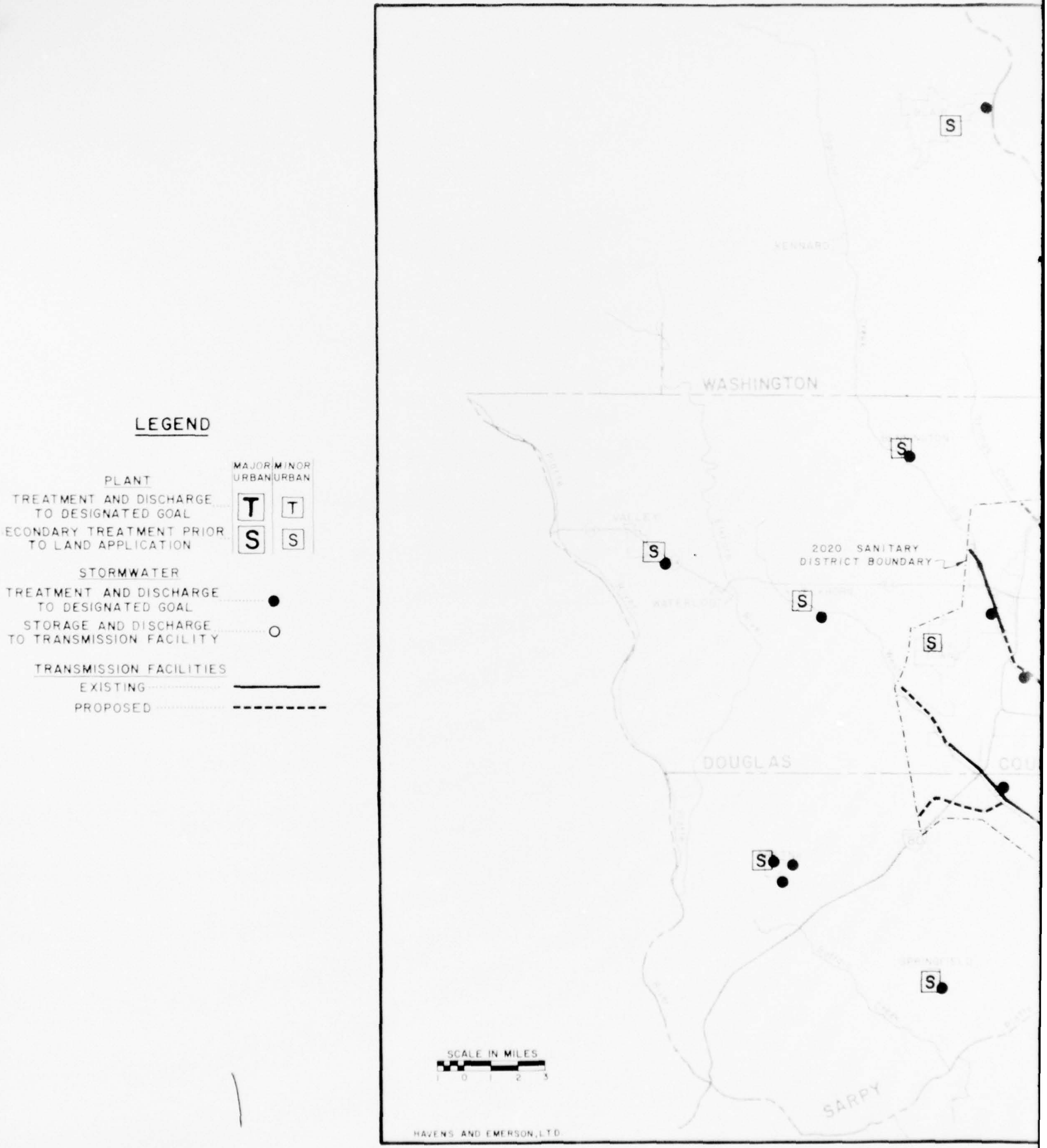
PLATE C-7

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

PLAN VI
LAND TREATMENT AREAS

U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

N, LTD.


LEGEND
PLANT
MAJOR URBAN
MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
ECONDARY TREATMENT PRIOR TO LAND APPLICATION
STORMWATER
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
STORAGE AND DISCHARGE TO TRANSMISSION FACILITY
TRANSMISSION FACILITIES
EXISTING
PROPOSED
WASHINGTON
DOUGLAS
SARPY
2020 SANITARY DISTRICT BOUNDARY
SCALE IN MILES
1 0 1 2 3
HAVENS AND EMERSON, LTD.

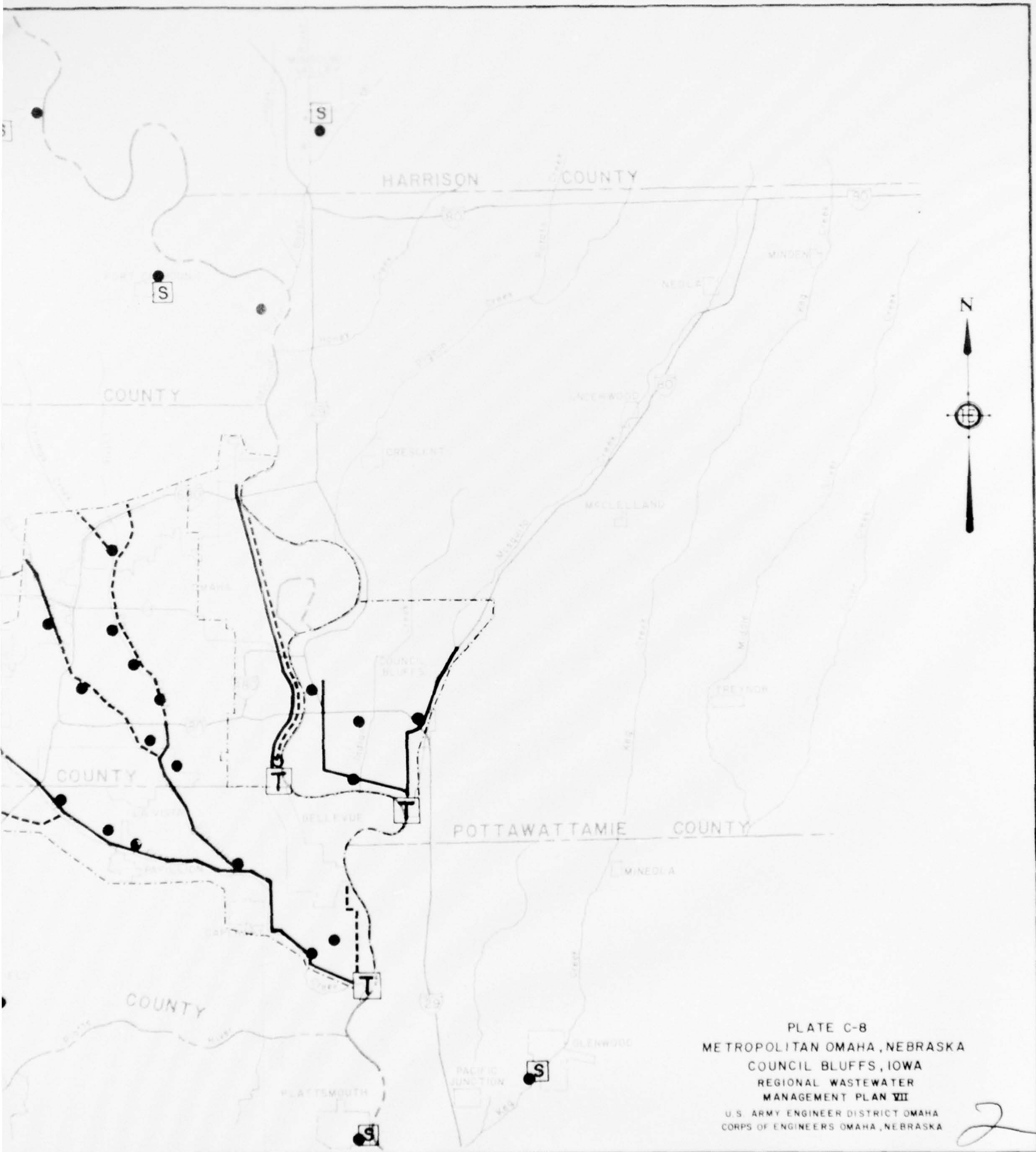


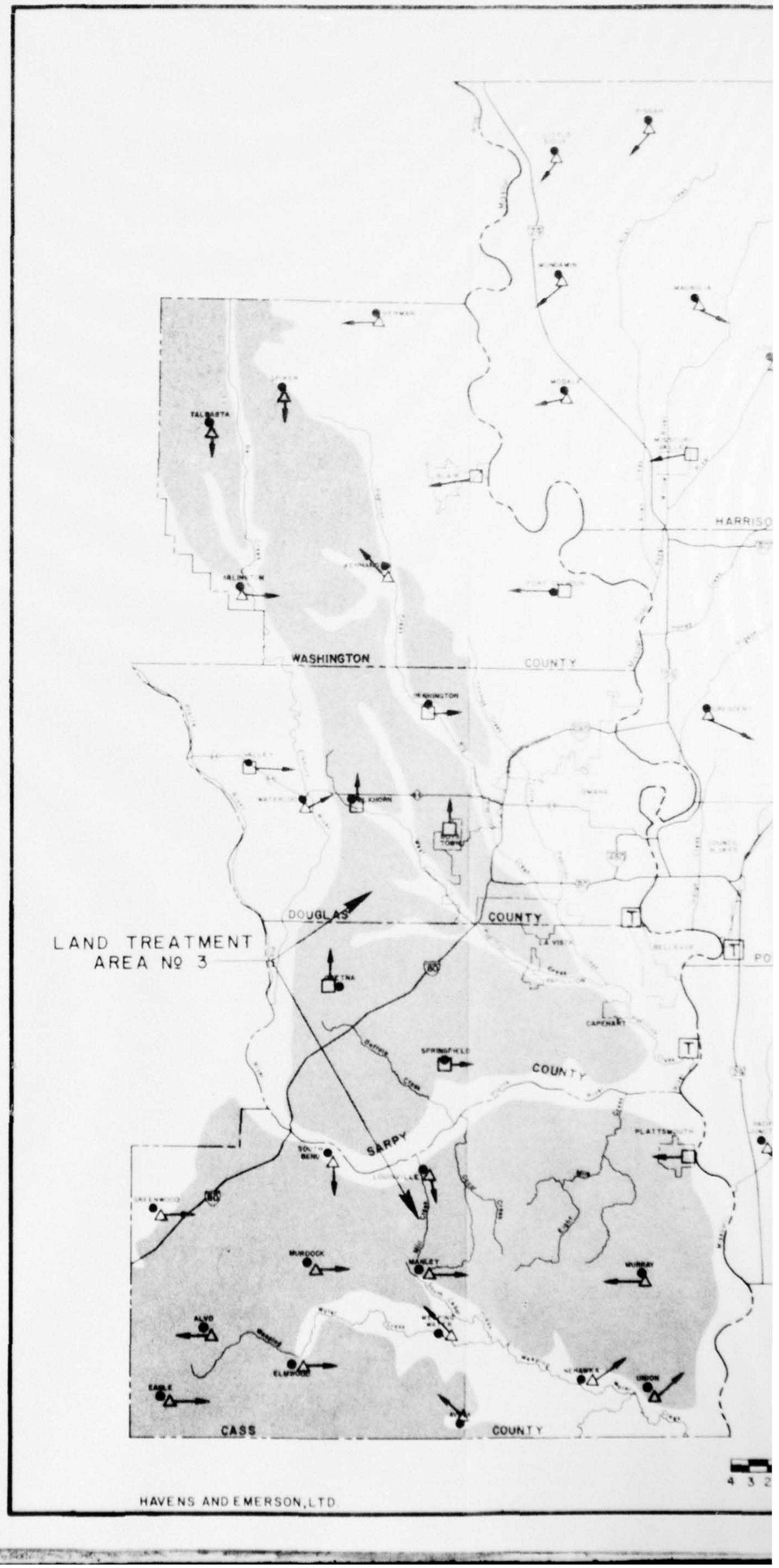
PLATE C-8
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN VII
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

LEGEND

□ MINOR URBAN WASTEWATER TREATMENT PLANTS

[T] MAJOR URBAN WASTEWATER TREATMENT PLANTS

△ NON URBAN WASTEWATER TREATMET PLANTS



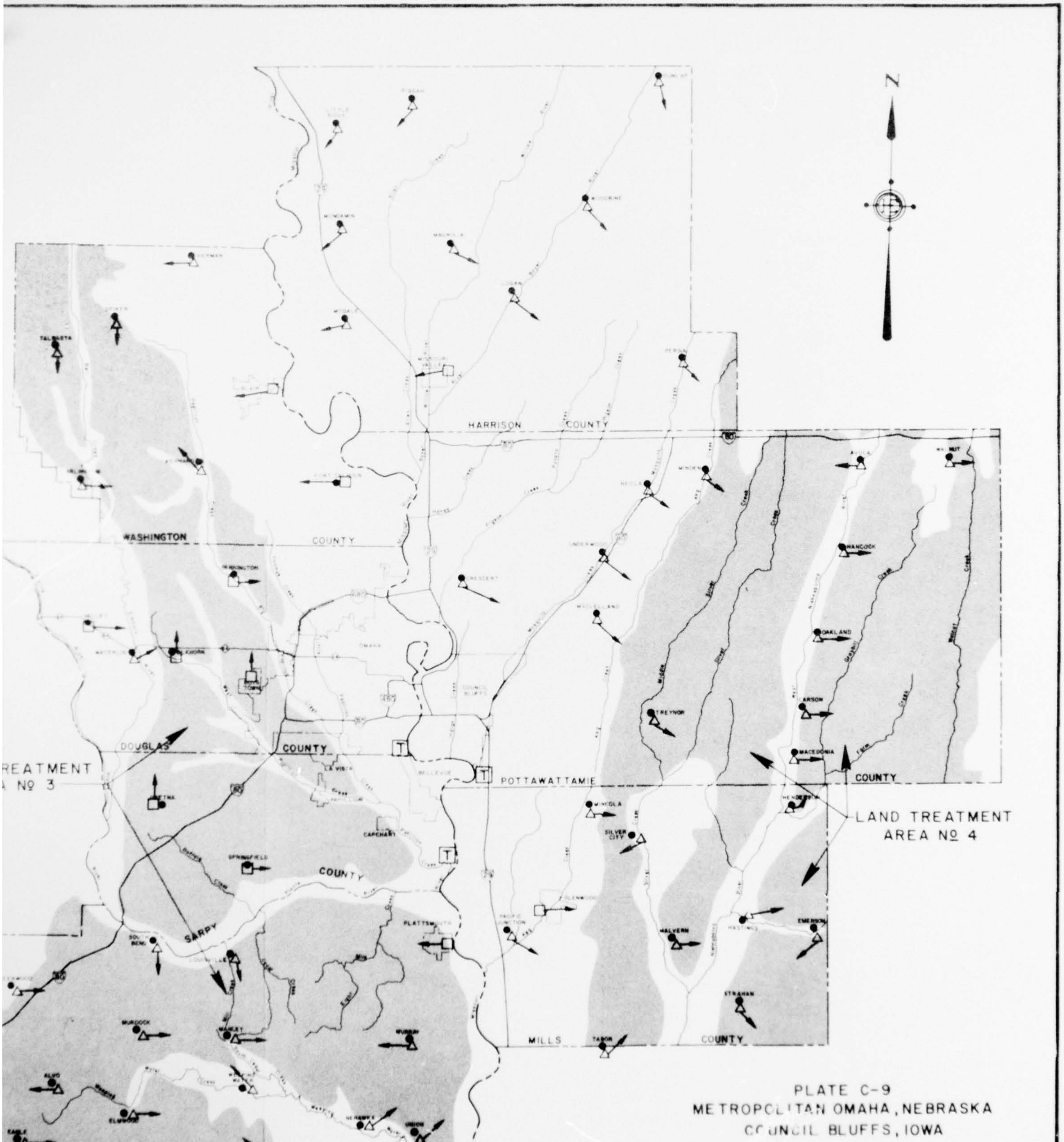
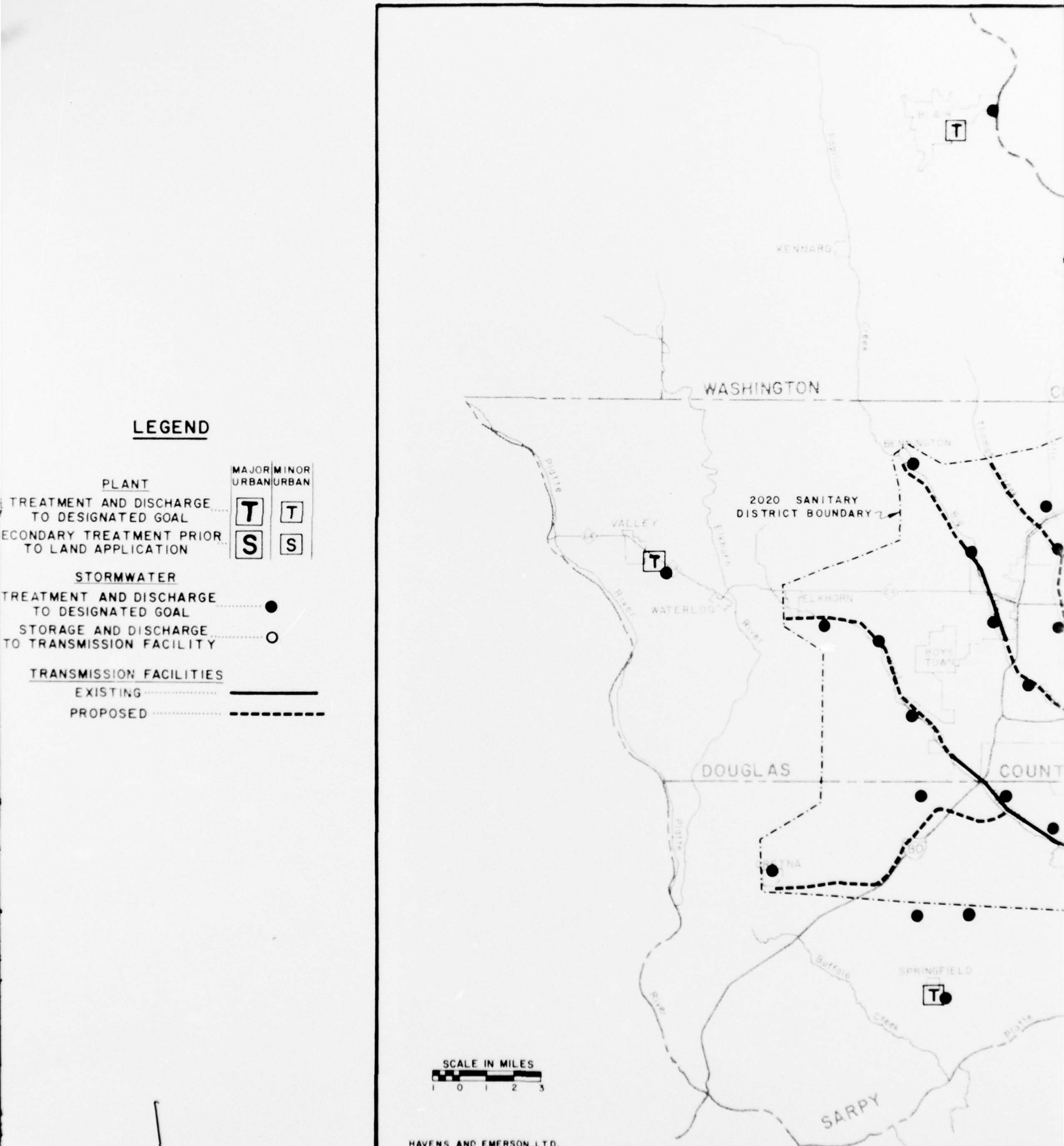


PLATE C-9
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
PLAN VII
LAND TREATMENT AREAS
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA



LEGEND
PLANT
MAJOR URBAN
MINOR URBAN
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
ECONDARY TREATMENT PRIOR TO LAND APPLICATION
T
S
STORMWATER
TREATMENT AND DISCHARGE TO DESIGNATED GOAL
STORAGE AND DISCHARGE TO TRANSMISSION FACILITY
TRANSMISSION FACILITIES
EXISTING
PROPOSED
WASHINGTON
DOUGLAS
COUNT
SARPY
2020 SANITARY DISTRICT BOUNDARY
KENNARD
VALLEY
WATERLOO
ELKHORN
BOYS TOWN
SPRINGFIELD
SCALE IN MILES
1 0 1 2 3
HAVENS AND EMERSON, LTD.

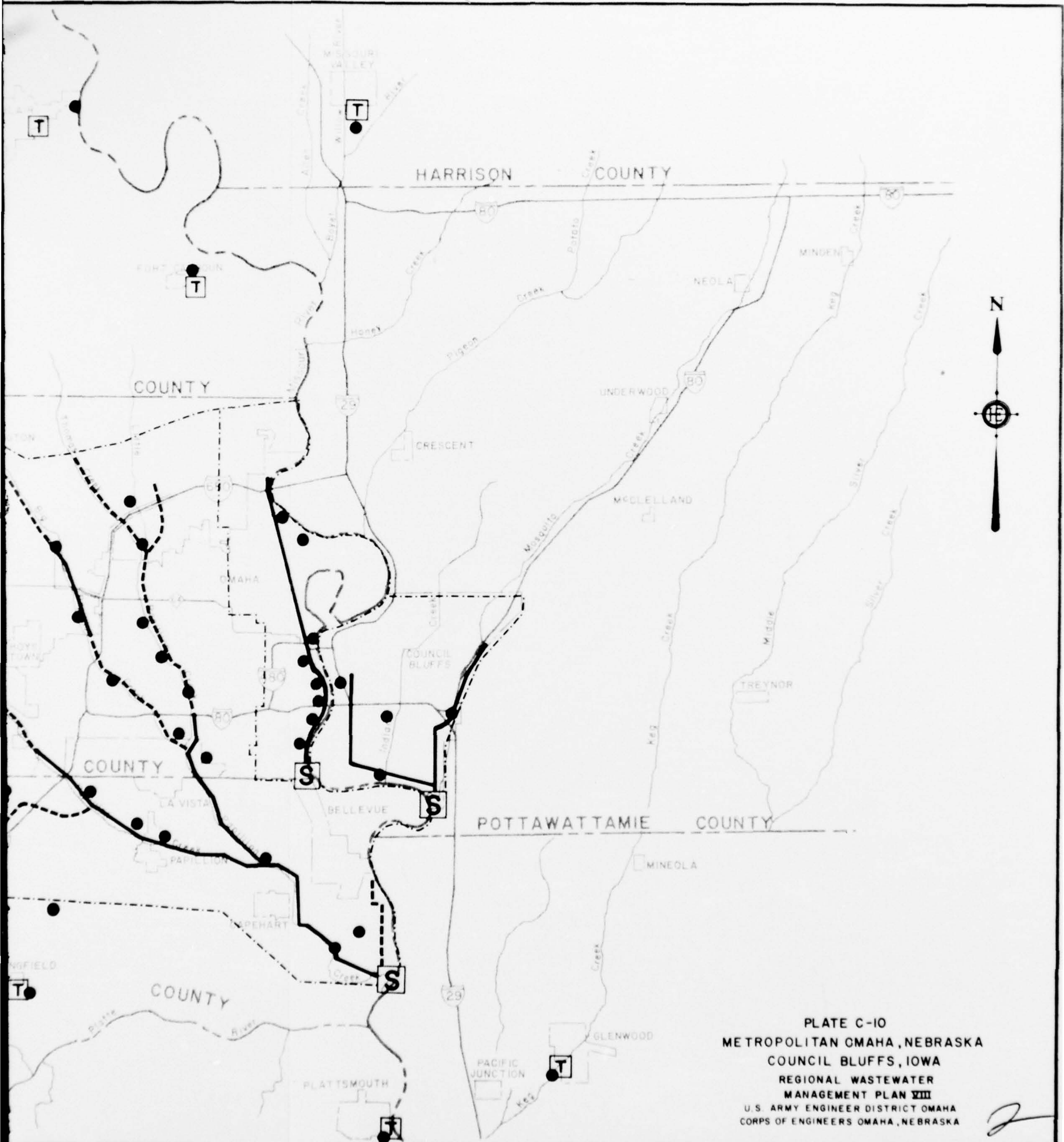
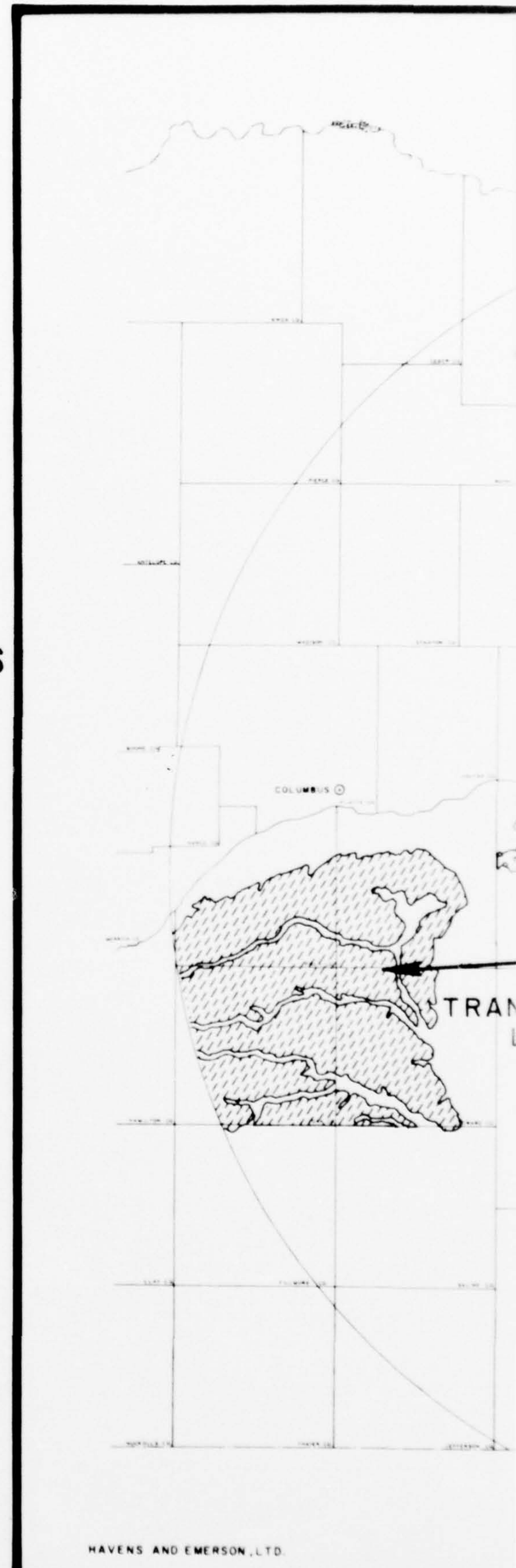


PLATE C-10
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
REGIONAL WASTEWATER
MANAGEMENT PLAN VIII
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

LEGEND

LAND TREATMENT PRIORITY OF SITES

- №1 23 AND 22 - Nebraska
- №2 29 AND 30 - Nebraska
- №3 21, 22 AND 26 - Nebraska
- №4 26 AND 29 - Iowa
- №5 6 AND 14 - Iowa
- №6 12, 18, 33 AND 34 - Iowa



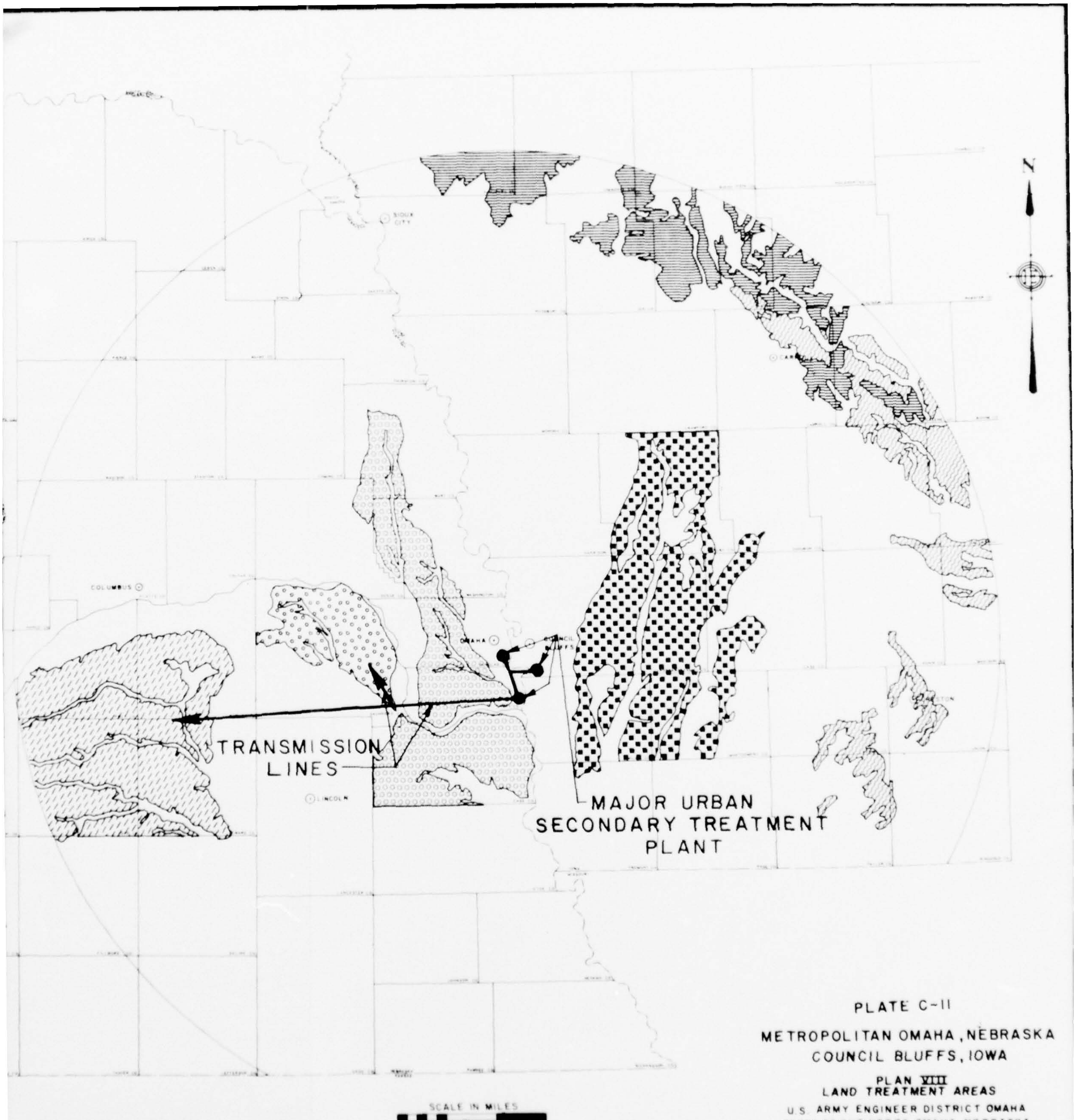


PLATE C-11

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

PLAN VIII
LAND TREATMENT AREAS

U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

...ND EMERSON, LTD.

APPENDIX D

MAJOR LAND TREATMENT OPTIONS 2 & 3

LAND TREATMENT CAPITAL COSTS
OPTION 2
(x $1,000)

Treatment Plants*	1985 A	1985 B	1985 C	1985 D	1990 A	1990 B	1990 C	1990 D	1995 A	1995 B	1995 C	1995 D	2000-2015(4) A	2000-2015(4) B	2000-2015(4) C	2000-2015(4) D	Total A	Total B	Total C	Total D
PL+M+CB																				
Irrigation-Facilities	31,574	28,163	31,687	25,029	8,648	5,284	8,833	9,376	4,402	3,779	4,218	3,955	4,402	3,779	4,218	3,955	62,232	52,342	61,610	54,180
Land	32,384	28,891	32,499	33,123	8,869	5,421	9,060	9,616	4,515	3,876	4,319	4,057	4,515	3,876	4,319	4,057	63,828	53,692	63,154	63,024
Storage-Facilities	8,880	7,721	8,962	9,205	-	-	-	-	5,423	4,901	5,269	4,984	-	-	-	-	14,303	12,622	14,231	14,189
Land	906	754	912	938	-	-	-	-	496	426	475	446	-	-	-	-	1,402	1,180	1,387	1,384
Conveyance	18,902	17,543	18,902	18,902	-	-	-	-	-	-	-	-	-	-	-	-	18,902	17,543	18,902	18,902
Total	92,646	83,072	92,962	87,197	17,517	10,705	17,893	18,992	14,836	12,982	14,281	13,442	8,917	7,655	8,537	8,012	160,667	137,379	159,284	151,679
PL+M																				
Irrigation-Facilities	27,475	24,356	27,621	28,324	7,347	4,265	7,476	8,223	3,512	2,992	3,330	2,997	3,512	2,992	3,330	2,997	52,382	43,581	51,747	51,532
Land	28,179	24,980	28,330	29,050	7,536	4,374	7,667	8,434	3,602	3,069	3,409	3,074	3,602	3,069	3,409	3,074	53,725	44,699	53,042	52,854
Storage-Facilities	7,433	6,394	7,508	7,799	-	-	-	-	4,173	3,770	4,023	3,669	-	-	-	-	11,606	10,164	11,531	11,468
Land	784	645	790	823	-	-	-	-	396	337	375	338	-	-	-	-	1,180	982	1,165	1,161
Conveyance	16,802	14,331	15,319	16,802	-	-	-	-	-	-	-	-	-	-	-	-	16,802	14,331	15,319	16,802
Total	80,673	70,706	79,568	82,798	14,883	8,639	15,143	16,657	11,683	10,168	11,137	10,078	7,114	6,061	6,739	6,071	135,695	113,757	132,804	133,817
PL																				
Irrigation-Facilities	13,748	11,249	13,162	14,389	5,616	3,154	5,068	6,255	2,634	1,875	2,256	2,210	2,634	1,875	2,256	2,210	32,534	23,778	29,510	31,694
Land	14,101	11,537	13,500	14,758	5,760	3,235	5,198	6,416	2,701	1,923	2,314	2,267	2,701	1,923	2,314	2,267	33,366	24,387	30,268	32,509
Storage-Facilities	4,078	3,218	3,956	4,348	-	-	-	-	2,941	2,272	2,592	2,539	-	-	-	-	7,019	5,490	6,548	6,887
Land	436	325	410	465	-	-	-	-	297	211	255	249	-	-	-	-	733	536	665	714
Conveyance	14,331	13,095	14,331	14,331	-	-	-	-	-	-	-	-	-	-	-	-	14,331	13,095	14,331	14,331
Total	46,694	39,424	45,359	48,291	11,376	6,389	10,266	12,671	8,573	6,281	7,417	7,265	5,335	3,798	4,570	4,477	87,983	67,286	81,322	86,135
PE-PL																				
Irrigation-Facilities	493	1,875	592	493	537	1,846	536	471	144	309	32	170	144	309	32	170	1,750	5,266	1,288	1,814
Land	506	1,924	607	506	550	1,890	549	483	148	317	33	174	148	317	33	174	1,796	5,399	1,321	1,859
Storage-Facilities	217	715	121	203	-	-	-	-	161	237	37	119	-	-	-	-	733	952	158	322
Land	24	83	26	22	-	-	-	-	15	35	103	19	-	-	-	-	39	118	129	41
Conveyance	988	1,236	0	988	-	-	-	-	-	-	-	-	-	-	-	-	988	1,236	0	988
Total	2,228	5,833	1,346	2,212	1,087	3,736	1,085	954	468	898	205	482	292	626	65	344	4,951	12,971	2,896	5,024

*M - Missouri River STP
CB - Council Bluffs STP
PL - Papillion STP limited sewer
PE - Papillion STP extended sewer

LAND TREATMENT CAPITAL COSTS
OPTION 3
(x $1,000)

Treatment Plants*	1985 A	1985 B	1985 C	1985 D	1990 A	1990 B	1990 C	1990 D	1995 A	1995 B	1995 C	1995 D	2000-2015(x4) A	2000-2015(x4) B	2000-2015(x4) C	2000-2015(x4) D	Total A	Total B	Total C	Total D
PL+M+CB																				
Irrigation-Facilities	29,955	26,725	30,061	30,639	8,204	5,015	8,380	8,895	4,176	3,586	3,995	3,753	4,176	3,586	3,995	3,753	59,039	49,670	58,416	58,299
Land	40,480	36,114	40,623	41,404	11,087	6,777	11,325	12,020	5,644	4,845	5,399	5,071	5,644	4,845	5,399	5,071	79,787	67,116	78,943	78,779
Storage-Facilities	8,880	7,721	8,962	9,205	-	-	-	-	5,423	4,901	5,269	4,984	-	-	-	-	14,303	12,622	14,231	14,189
Land	906	754	912	938	-	-	-	-	495	426	475	446	-	-	-	-	1,401	1,180	1,387	1,384
Conveyance	47,462	44,049	47,462	47,462	-	-	-	-	-	-	-	-	-	-	-	-	47,462	44,049	47,462	47,462
Total	127,683	115,363	128,020	129,648	19,291	11,792	19,705	20,915	15,738	13,758	15,138	14,254	9,820	8,431	9,394	8,824	201,992	174,637	200,439	200,113
PL+M																				
Irrigation-Facilities	26,065	23,107	26,205	26,872	6,971	4,064	7,092	7,801	3,332	2,838	3,154	2,844	3,332	2,838	3,154	2,844	49,696	41,343	49,067	48,893
Land	35,224	31,226	35,412	36,313	9,420	5,467	9,584	10,542	4,502	3,836	4,262	3,843	4,502	3,836	4,262	3,843	67,154	55,873	66,306	66,070
Storage-Facilities	7,433	6,394	7,508	7,799	-	-	-	-	4,173	3,770	4,023	3,669	-	-	-	-	11,606	10,164	11,531	11,468
Land	784	645	790	823	-	-	-	-	395	337	375	338	-	-	-	-	1,179	982	1,165	1,161
Conveyance	42,188	35,984	38,466	42,188	-	-	-	-	-	-	-	-	-	-	-	-	42,188	35,984	38,466	42,188
Total	111,694	97,356	108,381	113,995	16,391	9,513	16,676	18,343	12,402	10,781	11,814	10,694	7,834	6,674	7,416	6,687	171,823	144,346	166,535	169,780
PL																				
Irrigation-Facilities	13,043	10,672	12,487	13,651	5,328	2,992	4,808	5,935	2,499	1,779	2,141	2,097	2,499	1,779	2,141	2,097	30,866	22,559	28,000	30,071
Land	17,626	14,421	16,875	18,447	7,200	4,044	6,497	8,020	3,377	2,404	2,89	2,833	3,377	2,404	2,893	2,833	41,711	30,485	37,837	40,632
Storage-Facilities	4,078	3,218	3,956	4,348	-	-	-	-	2,941	2,272	2,592	2,539	-	-	-	-	7,019	5,490	6,548	6,887
Land	436	325	410	465	-	-	-	-	297	211	255	249	-	-	-	-	733	536	665	714
Conveyance	35,984	32,882	35,984	35,984	-	-	-	-	-	-	-	-	-	-	-	-	35,984	32,882	35,984	35,984
Total	71,167	61,518	69,712	72,895	12,528	7,036	11,305	13,955	9,114	6,666	7,881	7,718	5,876	4,183	5,034	4,930	116,313	91,952	109,034	114,288
PE-PL																				
Irrigation-Facilities	328	739	81	724	357	728	73	691	137	293	31	283	137	293	31	283	1,370	2,932	309	2,830
Land	443	999	109	557	482	983	99	531	185	396	42	218	185	396	42	218	1,850	3,962	418	2,178
Storage-Facilities	217	715	121	203	-	-	-	-	161	237	37	119	-	-	-	-	378	952	158	322
Land	24	83	26	22	-	-	-	-	15	35	103	19	-	-	-	-	39	118	129	41
Conveyance	2,482	3,102	0	2,482	-	-	-	-	-	-	-	-	-	-	-	-	2,482	3,102	0	2,482
Total	3,494	5,638	337	3,988	839	1,711	172	1,222	498	961	213	639	322	689	73	501	6,119	11,066	1,014	7,853

*M - Missouri River STP
CB - Council Bluffs STP
PL - Papillion STP limited sewer
PE - Papillion STP extended sewer

PRESENT WORTH OF LAND TREATMENT

OPTION 2
($1,000)

To Land Treatment

PAPILLION

Component	Growth Concept A	B	C	D
Irrigation Facilities	7,623	5,755	7,108	7,838
Irrigation and Drainage	13,990	10,562	13,046	14,385
Storage Facilities	3,424	2,687	3,244	3,473
Land Irrigation	12,184	9,198	11,366	12,552
Land Storage	332	243	305	335
Conveyance	7,907	7,162	7,159	7,891
O&M of Irrigation Facilities	12,706	9,574	12,451	13,062
O&M of Conveyance	7,567	5,727	7,084	7,843
Maximum Total	58,110	45,153	54,655	59,541
Intermediate Total	45,926	35,955	43,289	46,989
Minimum Total	39,559	31,148	37,351	40,442

PRESENT WORTH OF LAND TREATMENT

OPTION 2
($1,000)

To Land Treatment

PAPILLION
MISSOURI

Component	Growth Concept A	B	C	D
Irrigation Facilities	14,562	11,357	13,517	13,821
Irrigation and Drainage	26,726	20,844	24,808	25,365
Storage Facilities	5,886	5,117	5,889	5,965
Land Irrigation	21,158	18,175	21,648	22,157
Land Storage	560	463	558	567
Conveyance	13,151	11,133	12,058	13,023
O&M of Irrigation Facilities	22,460	18,851	22,478	23,002
O&M of Conveyance	13,570	11,408	13,593	13,961
Maximum Total	103,511	85,991	101,032	104,040
Intermediate Total	82,353	67,816	79,384	81,883
Minimum Total	70,189	58,329	68,093	70,339

PRESENT WORTH OF LAND TREATMENT

OPTION 3

($1,000)

To Land Treatment

PAPILLION

Component	Growth Concept A	B	C	D
Irrigation Facilities	7,354	5,551	6,856	7,561
Irrigation and Drainage	13,273	10,019	12,374	13,647
Storage Facilities	3,424	2,687	3,244	3,473
Land Irrigation	15,230	11,498	14,210	15,687
Land Storage	332	243	305	335
Conveyance	19,470	17,666	19,374	19,438
O&M of Irrigation Facilities	12,706	9,574	12,451	13,062
O&M of Conveyance	15,123	11,454	14,157	15,686
Maximum Total	79,558	63,141	76,115	81,328
Intermediate Total	64,328	51,643	61,905	65,641
Minimum Total	58,409	47,175	56,387	59,555

PRESENT WORTH OF LAND TREATMENT

OPTION 3
($1,000)

To Land Treatment

PAPILLION
MISSOURI

Component	Growth Concept A	B	C	D
Irrigation Facilities	13,031	10,957	13,036	13,332
Irrigation and Drainage	23,520	19,776	23,528	24,063
Storage Facilities	5,886	5,117	5,889	5,965
Land Irrigation	27,037	22,721	27,561	27,700
Land Storage	560	463	558	567
Conveyance	27,362	22,697	24,800	27,106
O&M of Irrigation Facilities	22,460	18,851	22,478	23,002
O&M of Conveyance	27,128	22,804	27,198	27,922
Maximum Total	133,953	112,429	132,012	136,325
Intermediate Total	106,916	89,708	104,451	108,625
Minimum Total	96,437	80,889	93,959	97,894

PRESENT WORTH OF LAND TREATMENT

OPTION 3

($1,000)

To Land Treatment

PAPILLION
MISSOURI
COUNCIL BLUFFS

Component	Growth Concept A	B	C	D
Irrigation Facilities	15,178	12,890	15,183	15,421
Irrigation and Drainage	27,394	23,265	27,404	27,833
Storage Facilities	7,165	6,284	7,169	7,236
Land Irrigation	31,375	26,719	31,500	32,020
Land Storage	658	550	656	663
Conveyance	40,112	37,128	39,792	39,792
O&M of Irrigation Facilities	26,153	22,184	26,170	26,593
O&M of Conveyance	31,510	26,760	31,579	32,166
Maximum Total	164,367	142,890	164,270	166,303
Intermediate Total	132,992	116,171	132,770	134,283
Minimum Total	120,776	105,796	120,549	121,871

PRESENT WORTH OF LAND TREATMENT

OPTION 3
($1,000)

To Land Treatment

PAPILLION EXTENSION - PAPILLION LIMITED

Component	Growth Concept A	B	C	D
Irrigation Facilities	273	590	62	571
Irrigation and Drainage	492	1,064	111	1,030
Storage Facilities	183	516	86	161
Land Irrigation	563	1,219	132	671
Land Storage	17	57	42	17
Conveyance	1,591	1,709	32	1,431
O&M of Irrigation Facilities	632	2,163	613	622
O&M of Conveyance	736	2,588	759	725
Maximum Total	2,782	9,316	1,775	4,657
Intermediate Total	2,219	8,097	1,643	3,986
Minimum Total	2,000	7,623	1,594	3,527

PRESENT WORTH OF LAND TREATMENT

OPTION 2

($1,000)

To Land Treatment

PAPILLION
MISSOURI
COUNCIL BLUFFS

Component	Growth Concept			
	A	B	C	D
Irrigation Facilities	15,733	13,359	15,741	13,304
Irrigation and Drainage	28,874	24,517	28,890	24,417
Storage Facilities	7,165	6,284	7,169	7,236
Land Irrigation	25,635	21,375	25,700	25,615
Land Storage	658	550	656	663
Conveyance	19,772	18,454	19,612	19,612
O&M of Irrigation Facilities	26,153	22,184	26,170	26,593
O&M of Conveyance	15,755	13,386	15,790	16,089
Maximum Total	124,012	106,750	123,987	120,225
Intermediate Total	98,377	85,375	98,287	94,610
Minimum Total	85,236	74,217	85,138	83,497

PRESENT WORTH OF LAND TREATMENT

OPTION 2

($1,000)

To Land Treatment

PAPILLION EXTENSION - PAPILLION LIMITED

Component	Growth Concept			
	A	B	C	D
Irrigation Facilities	378	1,288	365	372
Irrigation and Drainage	693	2,364	670	682
Storage Facilities	183	516	86	161
Land Irrigation	603	12,097	588	648
Land Storage	17	57	42	17
Conveyance	669	697	16	589
O&M of Irrigation Facilities	632	2,163	613	622
O&M of Conveyance	368	1,300	380	368
Maximum Total	3,165	13,284	2,395	3,087
Intermediate Total	2,562	7,097	1,807	2,439
Minimum Total	2,247	6,021	1,502	2,129

APPENDIX E

SEWER USE ORDINANCES-LINCOLN, NEBRASKA

Chapter 17.60

SEWER USE CHARGE

Sections:

17.60.020 Collection districts. For the convenient and economical computation of such use charge for all premises, the director of public utilities shall divide the city into billing cycles in such a manner as he shall determine fit using a winter quarter as a base. (Ord. 9284 §2; July 31, 1967: prior Ord. 8204 §1; September 30, 1963: Ord. 6589 §2; June 3, 1957).

17.60.050 Private water supply. Users of the sanitary sewage system of the City of Lincoln having a private water supply which is discharged into such sanitary sewage system shall meter same at the user's expense and be billed at the same rate as that applied to like customers using the city water supply. Where, in the judgment of the director of public utilities, by reason of special or unusual conditions, such meter requirements would be inequitable or unfair to the user, a special rate may be established by administrative rule or regulation, with approval of the mayor. (Ord. 9284 §4; July 31, 1967: prior Ord. 8204 §2; September 30, 1963: Ord. 7835 §2; August 13, 1962: Ord. 6589 §5; June 3, 1957).

17.60.070 Special rates. Where, in the judgment of the director of public utilities, by reason of special conditions, the application of the use charges hereinbefore set forth would be inequitable or unfair to either the city or the user, or in cases where the character of the sewage from a non-residential user is such that an additional burden is placed upon the sewage system greater than that imposed by the average sewage delivered to the sewage disposal plant, a special rate may be established by a contract or by administrative rule or regulation with the approval of the mayor. (Ord. 9284 §6; July 31, 1967: prior Ord. 8204 §3; September 30, 1963: Ord. 6589 §7; June 3, 1957).

17.60.090 Sewer use charge a lien. The sewer use charges provided for in this chapter, together with all other charges and penalties, shall be and are hereby declared to be a lien upon the property from the time such charge becomes due until paid, and may be collected from either the owner or the person, firm or corporation requesting the service, and may be collected in the same manner as other municipal taxes are certified, assessed, collected and returned. (Ord. 6589 §9; June 3, 1957).

17.60.120 Sanitary sewer system created. There is hereby created the Lincoln sanitary sewer system for the purpose of performing the functions of the sanitary sewage collection, treatment and disposal, and charged with the administration of the provisions of this chapter, all under the direction of the mayor and director of public utilities. The personnel and facilities of the Lincoln water system shall be utilized to bill and collect sewage use charges and to conduct such other administrative and business affairs of the Lincoln sanitary sewer system as the director may direct. (Ord. 9284 §8; July 31, 1967: prior Ord. 8204 §5; September 30, 1963; Ord. 6589 §12; June 3, 1957).

#70-51 Date to be Introduced: 3-23-70

ORDINANCE NO. [illegible]

AN ORDINANCE amending Title 17 of the Lincoln Municipal Code by adding thereto a new chapter to be numbered 17.58 entitled "Regulation of Sewer Use," regulating the use of public sewers and drains and the discharge of waters and wastes into the public sewer system, providing penalties for violations thereof, providing for a hearing board, and repealing all ordinances and parts of ordinances in conflict herewith.

BE IT ORDAINED by the City Council of the City of Lincoln, Nebraska:

Section 1. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding thereto a new section to be numbered Section 17.58.010 to read as follows:

"17.58.010 Definitions. Unless the context specifically indicates otherwise, the meaning of terms used in this chapter shall be as follows:

(a) "BOD" (denoting biochemical oxygen demand) shall mean the quantity of oxygen utilized in the biochemical oxidation of organic matter under standard laboratory procedure in five (5) days at 20° C, expressed in milligrams per liter.

(b) "Building drain" shall mean that part of the lowest horizontal piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of a building and conveys it to the building sewer, the building sewer beginning outside the outer wall of the building.

(c) "Building sewer" shall mean the extension from the building drain to the public sewer or other place of disposal.

(d) "City" shall mean the City of Lincoln, Nebraska.

(e) "Combined sewer" shall mean a public sewer receiving both surface runoff and sewage.

(f) "Director" shall mean the Director of Public Utilities of the City of Lincoln, Nebraska, or his authorized deputy, agent, or representative.

(g) "Garbage" shall mean solid wastes from the domestic and commercial preparation, cooking, and dispensing of food, and from the handling, storage, and sale of produce.

(h) "Industrial wastes" shall mean the liquid wastes from industrial manufacturing processes, trade, or business as distinct from sanitary sewage.

(i) "Natural outlet" shall mean any outlet into a watercourse, pond, ditch, lake, or other body of surface or groundwater.

(j) "Owner" shall mean any person who, alone or jointly or severally with others, has legal title to or charge, care, or control of in any capacity of property.

(k) "Person" shall mean any individual, firm, company, association, society, corporation, or group.

(l) "pH" shall mean the logarithm of the reciprocal of the weight of hydrogen ions in grams per liter of solution.

(m) "Properly shredded garbage" shall mean the wastes from the preparation, cooking, and dispensing of food that have been shredded to such a degree that all particles will be carried freely under the flow conditions normally prevailing in public sewers, with no particle greater than one-half (1/2) inch (1.27 centimeters) in any dimension.

(n) "Property" shall mean any piece or portion of real estate, including all buildings and structures located thereon, having a sewer or drainage system which immediately or remotely discharges into a public sewer, natural outlet, or both.

(o) "Public sewer" shall mean a sewer which is controlled by public authority.

(p) "Residence" shall mean property, or that portion of property, used exclusively as a dwelling or living quarters by one or more natural persons.

(q) "Sanitary sewer" shall mean a public sewer which carries sewage and to which storm, surface, and groundwaters are not intentionally admitted.

(r) "Sewage" shall mean a combination of the water-

carried wastes from property, together with such ground, surface, and stormwaters as may be present.

(s) "Sewage treatment plant" shall mean any arrangement of devices and structures used for treating sewage.

(t) "Sewage works" shall mean all facilities for collecting, pumping, treating, and disposing of sewage.

(u) "Sewer" shall mean a pipe or conduit for carrying sewage.

(v) "Shall" is mandatory; "May" is permissive.

(w) "Slug" shall mean any discharge of water, sewage, or industrial waste which in concentration of any given constituent or in quantity of flow exceeds for any period of duration longer than fifteen (15) minutes more than five (5) times the average twenty-four (24) hour concentration or flows during normal operation.

(x) "Storm sewer" shall mean a public sewer which carries storm and surface waters and drainage, but excludes sewage and industrial wastes, other than unpolluted cooling water.

(y) "Suspended solids" shall mean solids that either float on the surface of, or are in suspension in water, sewage, or other liquids, and which are removable by laboratory filtering.

(z) "Watercourse" shall mean a channel in which a flow of water occurs, either continuously or intermittently.

(aa) "Hearing board" shall mean that board appointed according to provisions of Section 17.58.180 of this chapter."

Section 2. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding thereto a new section to be numbered Section 17.58.020 to read as follows:

"17.58.020 Discharge of untreated sewage--Unlawful. It shall be unlawful to discharge to any natural outlet within the City or within three miles of the corporate limits thereof, or in any area under the jurisdiction of the City, any sewage, industrial wastes, or other polluted waters, except where suitable treatment has been provided in accordance with subsequent provisions of this chapter."

Section 3. That Title 17 of the Lincoln Municipal Code

be and it hereby is amended by adding thereto a new section to be numbered Section 17.58.030 to read as follows:

"17.58.030 <u>Discharges into sanitary sewers--Types not permitted</u>. No person shall discharge or cause to be discharged any stormwater, surface water, groundwater, roof runoff, or subsurface drainage, to any sanitary sewer. Uncontaminated cooling water and unpolluted industrial process waters may be discharged to a sanitary sewer only if expressly authorized by the director."

Section 4. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding thereto a new section to be numbered Section 17.58.040 to read as follows:

"17.58.040 <u>Discharge of stormwater and other unpolluted waters</u>. Stormwater and all other unpolluted drainage shall be discharged to such sewers as are specifically designated as combined sewers or storm sewers, or to a natural outlet approved by the director. Industrial cooling water or unpolluted process waters shall be discharged, at the request of the director, to a storm sewer, combined sewer, or natural outlet."

Section 5. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.050 to read as follows:

"17.58.050 <u>Discharges into public sewers--Types not permitted</u>. No person shall discharge or cause to be discharged any of the following described waters or wastes to any public sewer:

(a) Any gasoline, benzene, naphtha, fuel oil, or other flammable or explosive liquid, solid, or gas.

(b) Any waters or wastes containing toxic or poisonous solids, liquids, or gases in sufficient quantity, either singly or by interaction with other wastes, to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, create a public nuisance, or create any hazard in the receiving waters of the sewage treatment plant, including but not limited to cyanides in excess of two (2) mg/l as CN in the wastes as discharged to the public sewer.

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(c) Any waters or wastes having a pH lower than 5.5, or having any other corrosive property capable of causing damage or hazard to structures, equipment, and personnel of the sewage works.

(d) Solid or viscous substances in quantities or of such size capable of causing obstruction to the flow in sewers, or other interference with the proper operation of the sewage works such as, but not limited to, ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, unground garbage, whole blood, paunch manure, hair and fleshings, entrails and paper dishes, cups, towels, milk containers, etc., either whole or ground by garbage grinders."

Section 6. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.060 to read as follows:

"17.58.060 Discharges into public sewers--Types permitted at discretion of director. No person shall discharge or cause to be discharged to any public sewer the following described substances, materials, waters, or wastes if it appears likely in the opinion of the director that such wastes can harm the public sewers, sewage treatment process, or equipment, have an adverse effect on the receiving stream, or can otherwise endanger life, limb, public property, or constitute a nuisance. In forming his opinion as to the acceptability of these wastes, the director will give consideration to such factors as the quantities of subject wastes in relation to flows and velocities in the sewers, materials of construction of the sewers, nature of the sewage treatment process, capacity of the sewage treatment plant, degree of treatability of wastes in the sewage treatment plant, and other pertinent factors. The substances prohibited are:

(a) Any liquid or vapor having a temperature higher than one hundred fifty (150)° F (65°C).

(b) Any water or waste containing fats, wax, grease, or oils, whether emulsified or not, in excess of one hundred (100)

mg/l or containing substances which may solidify or become viscous at temperatures between thirty-two (32) and one hundred fifty (150)° F (0 and 65°C).

(c) Any garbage that has not been properly shredded. The installation and operation of any garbage grinder equipped with a motor of three-fourths (3/4) horsepower (0.76 hp metric) or greater shall be subject to the review and approval of the director.

(d) Any waters or wastes containing strong acid iron pickling wastes, or concentrated plating solutions.

(e) Any waters or wastes containing iron, chromium, copper, zinc, and similar objectionable or toxic substances; or wastes exerting an excessive chlorine requirement, to such degree that any such material received in the composite sewage at the sewage treatment works exceeds the limits established by the director for such materials.

(f) Any waters or wastes containing phenols or other taste- or odor-producing substances, in such concentrations exceeding limits which may be established by the director as necessary, after treatment of the composite sewage, to meet the requirements of the state, federal, or other public agencies of jurisdiction for such discharge to the receiving waters.

(g) Any radioactive wastes or isotopes of such half-life or concentration as may exceed limits established by the director in compliance with applicable state or federal regulations.

(h) Any waters or wastes having a pH in excess of 9.5.

(i) Materials which exert or cause:

(1) Unusual concentrations of inert suspended solids (such as, but not limited to, Fullers earth, lime slurries, and lime residues) or of dissolved solids (such as, but not limited to, sodium chloride and sodium sulfate).

(2) Excessive discoloration (such as, but not limited to, dye wastes and vegetable tanning solutions).

(3) Unusual BOD, chemical oxygen demand, or chlorine requirements in such quantities as to constitute a signi-

ficant load on the sewage treatment works.

(4) Unusual volume of flow or concentration of wastes constituting slugs.

(j) Waters or wastes containing substances which are not amenable to treatment or reduction by the sewage treatment processes employed, or are amenable to treatment only to such degree that the sewage treatment plant effluent cannot meet the requirements of other agencies having jurisdiction over discharge to the receiving waters."

Section 7. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.070 to read as follows:

"17.58.070 Prohibited discharges--Nature of director's discretion with respect to. If any waters or wastes are discharged, or are proposed to be discharged to the public sewers, which waters contain the substances or possess the characteristics enumerated in Section 17.58.060 of this chapter, and which in the judgment of the director, may have a deleterious effect upon the sewage works, processes, equipment, or receiving waters, or which otherwise create a hazard to life or constitute a public nuisance, the director may:

(a) Reject the wastes,

(b) Require pretreatment to an acceptable condition for discharge to the public sewers,

(c) Require control over the quantities and rates of discharge, and/or

(d) Require payment to cover the added cost of handling and treating the wastes not covered by existing taxes or sewer charges under the provisions of Chapter 17.60 of this title.

If the director permits the pretreatment or equalization of waste flows, the design and installation of the plants and equipment shall be subject to the review and approval of the director, and subject to the requirements of all applicable codes, ordinances, and laws."

Section 8. That Title 17 of the Lincoln Municipal

Code be and it hereby is amended by adding a new section to be numbered Section 17.58.080 to read as follows:

"17.58.080 Grease, oil, and sand interceptors--When required. Grease, oil, and sand interceptors shall be provided by the owner of a property when, in the opinion of the director, they are necessary for the proper handling of liquid wastes containing grease in excessive amounts, or any flammable wastes, sand, or other harmful ingredients; except that such interceptors shall not be required for residences. All interceptors shall be of a type and capacity approved by the director, and shall be located as to be readily and easily accessible for cleaning and inspection."

Section 9. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.090 to read as follows:

"17.58.090 Preliminary treatment or flow-equalizing facilities--Maintenance by owner. Where preliminary treatment or flow-equalizing facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner at his expense."

Section 10. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.100 to read as follows:

"17.58.100 Sampling stations--When required--Installation and maintenance. The owner of any property serviced by a building sewer carrying industrial wastes shall, at the request of the director, install a suitable sampling station or stations upon each and every building sewer or shall combine said building sewers into one common building sewer upon which one sampling station shall be placed. The sampling station or stations shall be furnished with such necessary meters and other appurtenances in the building sewer or sewers to facilitate observation, sampling, and measurement of the wastes. Such sampling station or stations shall be accessibly and safely located, and shall be constructed in accordance with plans approved by the director. The sampling station

or stations shall be installed by the owner at his expense, and shall be maintained by him so as to be safe and accessible at all times."

Section 11. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.110 to read as follows:

"17.58.110 Sampling of waters and wastes--Method of. All measurements, tests, and analyses of the characteristics of waters and wastes to which reference is made in this chapter shall be determined in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater," published by the American Public Health Association, and shall be determined at the sampling station provided, or upon suitable samples taken at said sampling station. Not less than three copies of the latest edition of said volume shall be kept on file in the office of the city clerk of the City for use and examination by the public. In the event that no special sampling station has been required, the sampling station shall be considered to be the nearest downstream manhole in the public sewer from the point at which the building sewer is connected. Sampling shall be carried out by customarily accepted methods to reflect the effect of constituents upon the sewage works and to determine the existence of hazards to life, limb, and property. (The particular analyses involved will determine whether a twenty-four (24) hour composite of all outfalls of a premises is appropriate or whether a grab sample or samples should be taken. Normally, but not always, BOD and suspended solids analyses are obtained from 24-hour composites of all outfalls whereas pH's are determined from periodic grab samples.)"

Section 12. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.120 to read as follows:

"17.58.120 Treatment of industrial waste--Special agreement with City. No statement contained in this chapter shall

be construed as preventing a special agreement or arrangement between the City and the owner of any property whereby an industrial waste of unusual strength or character may be accepted by the City for treatment, subject to payment therefor by the owner."

Section 13. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.130 to read as follows:

"17.58.130 Permit required. No person shall discharge or cause to be discharged to any public sewer any industrial wastes without a valid permit from the director. When the director has reason to believe that an owner of property has been discharging, is discharging, or is about to discharge any industrial wastes into a public sewer, he may request such person to file an application for such a permit, which application shall be completed and returned to the director within thirty (30) days after the receipt thereof.

All applications for a permit under this section shall require the applicant to provide: the name, address, and telephone number of the applicant; the location and legal description of the property to be covered by the permit; a general statement of the type of operations conducted and to be conducted on the property; a plat of the property showing accurately all sewers and drains; plans and specifications covering any work proposed to be performed under the permit; a complete schedule of all process waters and industrial wastes produced or expected to be produced for discharge from the property, including a description of the character of each waste, the daily volume and maximum rates of discharge, and representative analyses; and the name, address, and telephone number of the person who will perform the work covered by the permit. All applications shall also require the applicant to agree: to furnish at the request of the director any additional information relating to the installation or use of the industrial sewer for which the permit is sought; to accept and abide by all provisions of this chapter and all other pertinent

ordinances and regulations which may be adopted in the future; to operate and maintain any waste pretreatment facilities, as may be required as a condition of the acceptance into the public sewers of the industrial wastes involved, in an efficient manner at all times, and at no expense to the City; to cooperate at all times with the director in the inspecting, sampling, and study of the industrial wastes and in the inspecting of any facilities provided for pretreatment; and to notify the director immediately in the event of any accident, negligence, or other occurrence which occasions discharge to the public sewers of any wastes or process waters not covered by the permit.

If, after examination by the director of the information contained in an application for a permit hereunder, it is determined by the director that the characteristics of the proposed discharge do not conflict with the provisions of this chapter, a permit shall forthwith be issued allowing the discharge of such wastes to the public sewers. But, if it is determined by the director that the characteristics of the wastes are not in compliance with the provisions of this chapter, the application shall be denied by the director and the applicant forthwith advised by the director of steps which must be taken to insure compliance with the provisions of this chapter."

Section 14. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.140 to read as follows:

"17.58.140 Unauthorized damaging of equipment--Unlawful. It shall be unlawful for any person unauthorized by the City to damage, destroy, uncover, deface, or tamper with any structure, appurtenance, or equipment which is a part of the sewage works."

Section 15. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.150 to read as follows:

"17.58.150 Right of entry--Authority of director. The director shall be permitted to enter any property other than

residences at any time, and residences at such times as may be provided in the Uniform Inspections Code as now existing in the Lincoln Municipal Code or as may hereafter be amended, for the purpose of inspection, observation, measurement, sampling, or testing in accordance with the provisions of this chapter; provided, that (1) if such property be occupied he shall first present proper credentials to the occupant and request entry, explaining his reasons therefor, and (2) if such property be unoccupied, he shall first make a reasonable effort to locate the owner of such property and request entry, explaining his reasons therefor. If such entry is refused or cannot be obtained because the owner of such property cannot be found after due diligence, the director shall have recourse to every remedy provided by law to secure lawful entry for the above-stated purposes.

Notwithstanding the foregoing, if the director has reasonable cause to believe that waters or wastes of the types referred to in Sections 17.58.050 and 17.58.060 of this chapter are being discharged from any property into a public sewer or natural outlet, and has reasonable cause to believe that such discharge is so dangerous, hazardous, or unsafe as to require immediate inspection to safeguard the public health or safety, he shall have the right to immediately enter and inspect such property, and may use any reasonable means required to effect such entry and make such inspection, whether such property be occupied or unoccupied and whether or not permission to inspect has been obtained. If the property be occupied, he shall first present the proper credentials to the occupant and demand entry, explaining his reasons therefor and the purpose of his inspection. No person shall fail or refuse, after proper demand has been made upon him as provided in this paragraph, to promptly permit the director to make any inspection provided for by this paragraph. Any person violating this paragraph shall be guilty of a misdemeanor.

The director shall have no authority to inquire into any processes including metallurgical, chemical, oil, refining, ceramic,

paper, or other industries beyond that point having a direct bearing on the kind and source of discharge to the sewers or waterways or facilities for waste treatment.

While performing the necessary work on property referred to in this section, the director shall observe all applicable safety rules established by the owner of the property."

Section 16. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.160 to read as follows:

"17.58.160 Director relieved from personal liability. The City shall hold harmless the director, when acting in good faith and without malice, from all personal liability for any damage that may accrue to any person or property as a result of any act required by this chapter or by reason of any act or omission of the director in the discharge of his duties hereunder. Any suit brought against the director because of any such act or omission in the carrying out of the provisions of this chapter shall be defended by the city's law department through final determination of such proceedings."

Section 17. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.170 to read as follows:

"17.58.170 Penalties. Any person upon whom a duty is placed by the provisions of this chapter, who shall fail, neglect, or refuse to perform such duty, or who shall violate any of the provisions of this chapter, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine not to exceed five hundred dollars ($500) for each violation, together with the costs of prosecution. Each day that a violation of this chapter continues shall constitute a separate and distinct offense and shall be punishable as such.

Provided, however, that any person upon whom a duty is placed by the provisions of Sections 17.58.020, 17.58.030, 17.58.040, 17.58.050(d), 17.58.060, 17.58.080, 17.58.090, 17.58.100,

and 17.58.130 of this chapter, who shall fail, neglect, or refuse to perform such duty, or who shall violate any of the provisions of said sections, may be served by the City with written notice stating the nature of such duty or of such violation and providing a reasonable time limit for the satisfactory correction of such duty or violation. Such person shall, within such period of time, perform such duty or cease such violation; otherwise, for each day after such period of time that such person fails, neglects, or refuses to perform such duty or violates such provision, he shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished as above provided.

In addition to, or in lieu of, other remedies provided the City by this section to correct or abate a failure, neglect, or refusal to perform a duty imposed by this chapter or a violation of a provision of this chapter, the director may revoke any permit issued under the provisions of this chapter, and may effect the discontinuation of water or sewer service, or the discontinuation of both such services, to the owner of the property. The director may also institute injunction or other appropriate action or proceeding. However, with the exception of repeated nonaccidental discharges to the public sewers of waters or wastes of the types referred to in subsections (a), (b), and (c) of Section 17.58.050 of this chapter, the director shall give the owner at least fifteen (15) days' written notice before revoking such permit or discontinuing water or sewer service; except, that if within said fifteen-day period such owner requests a hearing before the hearing board as hereinafter provided, the director shall not revoke such permit nor discontinue such water or sewer service unless authorized by said board or by a court of competent jurisdiction upon appeal from said board.

Any person who accidentally discharges into a public sewer any waters or wastes of the types referred to in subsections (a), (b), or (c) of Section 17.58.050 of this chapter shall immediately notify the director by the quickest means available,

supplying him with all information pertaining to such discharge as the director may request to enable the director to take proper action to protect persons, public sewers, and sewage treatment processes which may be endangered by such discharge. Such an accidental discharge shall not constitute a violation of this chapter, provided that prompt report of such discharge is made to the director as aforesaid.

Any person upon whom a duty is placed by the provisions of this chapter, who shall fail, neglect, or refuse to perform such duty, or who shall violate any of the provisions of this chapter, or who is responsible for an accidental discharge as aforesaid, may be held liable to the City for any expense, loss, or damage occasioned the City by reason thereof."

Section 18. That Title 17 of the Lincoln Municipal Code be and is hereby is amended by adding a new section to be numbered Section 17.58.180 to read as follows:

"17.58.180 Hearing board. The mayor of the City shall appoint a hearing board to arbitrate differences between the director and any person aggrieved by any decision of the director concerning the interpretation and execution of any provision of this chapter. Such board shall be appointed within five (5) days after request therefor, setting forth the specific matter in dispute, has been filed with the mayor by such person. All costs of arbitration shall be divided equally between the City and the person requesting the board. The rate or amount of pay to be received by the board members shall be determined by the mayor before the board convenes.

All hearing boards shall be appointed ad hoc, but in selecting a given hearing board the mayor may appoint one or more members of any such prior-appointed board. The mayor may consult with the director and with the person requesting the board concerning the appointment of board members, but he shall make a reasonable effort not to appoint anyone who is employed by, retained by, or otherwise subject to control or influence of the director,

the person requesting the board, or the City. The mayor's decision as to choice of board members shall be final.

One member of each board shall be a registered professional engineer; one member shall be a practicing sanitary engineer; one member shall be a representative of industry or manufacturing enterprise; one member shall be a lawyer; and one member shall be selected at large for his interest in accomplishing the objectives of this chapter. No board shall have any other members.

Each hearing board shall convene within ten (10) days after it is appointed and elect its chairman and such other officers as it desires from among its members and shall establish its own rules of procedure, provided that three members shall constitute a quorum for the transaction of business and three affirmative votes shall be required for final action on any matter acted upon by the board. The board shall make specific findings and conclusions based upon the testimony and evidence properly presented to it, and shall render its decision based upon such findings and conclusions within thirty (30) days after the date the board convenes, and at the end of such period of time the board shall automatically cease to exist. Such decision shall be in full resolve of the said dispute. Neither the hearing board nor any member thereof shall in any way be liable to the City or to any person whomsoever for any such decision rendered by it. The decision of the board shall be binding upon the City and upon the person requesting the board, and its decision may be appealed by either or both parties to the District Court of Lancaster County, Nebraska.

Nothing contained in this section shall be construed to preclude any person aggrieved by any decision of the director concerning the interpretation and execution of any provision of this chapter from appealing such decision to the District Court of Lancaster County, Nebraska."

Section 19. That Title 17 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.58.190 to read as follows:

"17.58.190 Severability. If any section, subsection, paragraph, sentence, clause, phrase, or provision of this chapter shall be adjudged invalid, or held unconstitutional, the same shall not affect the validity of this chapter as a whole or any part or provision thereof, other than the part so declared to be invalid or unconstitutional."

Section 20. That all ordinances and parts of ordinances in conflict herewith be and they hereby are repealed.

Section 21. This ordinance shall take effect and be in force from and after its passage and publication according to law.

Introduced by

____

Approved as to Form:

____

City Attorney

71-38

To be introduced March 8, 1971

ORDINANCE NO **10130**

AN ORDINANCE *amending Chapter 17.60 of the Lincoln Municipal Code entitled* "Sewer Use Charge" by adding thereto a new section to be numbered 17.60.005 pertaining to definitions, new Sections 17.60.032, 17.60.034, 17.60.036, and 17.60.038, all pertaining to the making of a sewer use surcharge, and new Section 17.60.140 pertaining to the provision of a hearing board; amending said Chapter 17.60 by amending Section 17.60.010 pertaining to sewer use charge, Section 17.60.030 pertaining to the making *of a basic sewer use charge, Section 17.60.060 pertaining to sewage meters, Section 17.60.080 pertaining* to the turning off of water for nonpayment of sewer use charges, Section 17.60.100 pertaining to defective meters, Section 17.60.110 pertaining to billing adjustments, and Section 17.60.130 pertaining to commencement of billings; and repealing said Sections 17.60.010, 17.60.030, 17.60.060, 17.60.080, 17.60.100, 17.60.110, and 17.60.130 as hitherto existing and all other ordinances and parts of ordinances *in conflict herewith.*

BE IT ORDAINED by the City Council of the City of Lincoln, Nebraska:

Section 1. That Chapter 17.60 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.60.005 to read as follows:

17.60.005 Definitions. The definitions set forth in Section 17.58.010 of this title shall, except as otherwise specifically defined in this section, apply with like force and effect to this chapter, together with the following definitions:

(a) "Basic sewer use unit charge" shall mean the basic charge per one hundred cubic feet of water, or sewage if a sewage measuring device is required or permitted and used, made against a property for using the Lincoln Sanitary Sewer System, and shall be determined by dividing the total annual sewage *treatment and collection costs* (as defined) for the fiscal year of sewer use, by the total sewage flow, in hundreds of cubic feet, into the sewage treatment facilities of the Lincoln Sanitary Sewer System during the city's fiscal year immediately preceding the fiscal year of sewer use.

(b) "Chlorine requirement" shall mean the weight of chlorine, expressed in milligrams per liter, which must be added per unit volume to produce the desired result under stated conditions.

(c) "COD" *(denoting chemical oxygen demand)* shall mean the oxygen equivalent of that portion of an organic matter in a sample that is susceptible to oxidation by strong chemical oxident, expressed in milligrams per liter.

(d) "Dwelling unit" shall mean a room or rooms in which kitchen facilities are provided, located in a building or structure used by a family or household as a home or residence of the family or household.

(e) "Non-residential property" shall mean any property other than residential property.

(f) "Normal sewage" shall mean sewage which when analyzed shows by weight a daily average of not more than 300 parts per million (2,500 pounds) of suspended solids, not more than 250 parts per million (2,085 pounds) of BOD (or where biochemical oxygen demand cannot accurately be determined, a chemical oxygen demand greater than 400 parts per million (3,336 pounds)), and not more than 100 parts per million (834 pounds) of ether soluble matter (grease and oil), each per million gallons of daily flow.

(g) "p.p.m." (denoting parts per million) shall mean milligrams per liter.

(h) "Residential property" shall mean a property consisting primarily, on an area basis, of one or more dwelling units.

(i) "Sewage" shall mean any substance which is discharged into the Lincoln Sanitary Sewer System.

(j) "Total annual sewage treatment and collection costs" shall mean the total amount sufficient (1) to meet the costs and expenses of the operation and maintenance of the Lincoln Sanitary Sewer System, including both the sewage treatment and collection system facilities, (2) for the amortization of the indebtedness of said facilities, and (3) for additional costs as may be necessary to assure adequate waste collection/treatment on a continuing basis, all as pertaining to and reflecting the total operation of the Lincoln Sanitary Sewer System, as determined by the city council for one fiscal year.

(k) "Total annual sewage treatment costs" shall mean the total amount sufficient (1) to meet the costs and expenses of the operation and maintenance of the sewage treatment facilities, (2) for the amortization of the indebtedness of said facilities, and (3) for additional costs as may be necessary to assure adequate waste treatment on a continuing basis, all as pertaining to and reflecting the total operation of the sewage treatment facilities of the Lincoln Sanitary Sewer System, as determined by the city council for one fiscal year.

Section 2. That Section 17.60.010 of the Lincoln Municipal Code be and it hereby is amended to read as follows:

17.60.010. **Sewer use charge.** For the Purpose of providing revenue for the operation, maintenance, improvement, enlargement, and expansion of the sanitary sewer system of the City of Lincoln; for the purpose of providing revenue for the prevention of water and stream pollution by the control of sewage and its discharge; for the purpose of paying the principal and interest of any bonds issued for any of the aforesaid purposes; and for the purpose of creating reserves for any of the aforesaid purposes, and for no other purpose, there is hereby imposed a sanitary sewer use charge, including where appropriate both a basic sewer use charge and a sewer use surcharge, against each property served by said sanitary sewer system, or which may otherwise discharge sewage, either directly or indirectly, into such sewer system or any parts thereof or into any water or stream subject to the jurisdiction of the City of Lincoln. Such use charges, including the collection thereof, shall be as hereinafter provided.

Section 3. That Section 17.60.030 of the Lincoln Municipal Code be and it hereby is amended to read as follows:

17.60.030. **Basic sewer use charge.** Each property using the sanitary sewer system of the city shall be subject to a basic sewer use charge. For a given residential property, the basic sewer use charge for each billing cycle shall be determined by multiplying for each such cycle the total amount of water, in hundreds of cubic feet, metered for said property during a billing cycle chosen by the director from the most recent past winter, by the basic sewer use unit charge. For a given non-residential property, the basic sewer use charge for a given billing cycle shall be determined by multiplying for such cycle the total amount of water or sewage, in hundreds of cubic feet, measured for said property during such cycle, by the basic sewer use unit charge. The basic sewer use unit charge for any given property is hereby found and determined to be nineteen cents per one hundred cubic feet of water or sewage, as herein provided.

In the case of change of occupancy of residential property, if the director reasonably determines that to compute the basic sewer use charge for a given billing cycle upon the amount of water used by such property during such winter billing cycle would be inequitable either to the city or to the user, he shall use the average amount of water used by like users during such winter billing cycle to compute such charge.

Where a sewage flow meter or other sewage measuring device is required or permitted by the director and is used to measure the volume of sewage discharged into the Lincoln Sanitary Sewer System, such sewer use charge shall be computed thereon at the basic sewer use unit charge.

The director shall review the basic sewer use unit charge every year, or more often if conditions so warrant, and based upon such review shall make recommendations to the city council for their consideration.

Section 4. That Chapter 17.60 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.60.032 to read as follows:

17.60.032. Minimum sewer use charge. Regardless of whether a sewage meter is used, there shall be a minimum sewer use charge per month to each property using the Lincoln Sanitary Sewer System, determined by the number and size of the water meters serving such property, to-wit:

Water Meter Size	Minimum Sewer Use Charge per Water Meter
5/8 inch	$ 1.50
3/4 inch	1.50
1 inch	1.50
1 1/2 inch	3.00
2 inch	6.25
3 inch	15.50
4 inch	31.25
6 inch	62.50
8 inch	110.00
10 inch	150.00

For a multiple dwelling unit residential property, the monthly sewer use charge shall be at least $1.50 per dwelling unit.

Section 5. That Chapter 17.60 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.60.034 to read as follows:

17.60.034. Sewer use surcharge - When applicable. In addition to the basic sewer use charge required by section 17.60.030 of this chapter, when any property discharges into the Lincoln Sanitary Sewer System significant (as determined by the director) concentrations or quantities of industrial wastes or other high strength sewage, which sewage, as determined by the director, has a strength greater than normal sewage (as defined), such property shall be subject to a sewer use surcharge, to be determined as set forth in this chapter, the purpose of such surcharge being to help defray the extra cost to the city of treating such sewage.

Section 6. That Chapter 17.60 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.60.036 to read as follows:

17.60.036. Sewer use surcharge - Obtaining and analyzing sewage samples. For use in determining the sewer use surcharge to be made against a given property for a given period of time, the director shall sample and analyze the sewage discharge from such property into the Lincoln Sanitary Sewer System in order to determine the strength of such sewage over such period. Usually samples shall be taken from such sewage discharge on at least three composites during operations on such property. The director shall annually determine the unit cost ($/lb.) to the city of removing suspended solids, of removing

biochemical oxygen demand or chemical oxygen demand, and of other additional treatment required for industrial wastes, flowing into the city's sewage treatment facilities. Such determination by the director shall be made by dividing the total annual sewage treatment costs (as defined) established for the year of sewer use (with cost allocations being made for the removal of suspended solids, BOD or COD, and other substance requiring treatment), by the total annual pounds of suspended solids, BOD or COD, and other substance requiring treatment flowing into the city's sewage treatment facilities.

All such sampling and analyzing of the sewage discharge from a given property shall be in accordance with the provisions of sections 17.58.100 and 17.58.110 of this title, provided, however, that the director may in his discretion accept such sampling and analyzing results as may be submitted to him by the sewer user on such property if the director reasonably determines that such results properly reflect the overall nature of such discharge.

Each property for which more than two sampling stations are used shall reimburse the city for the city's sampling and analyzing costs resulting from samples taken from more than two of such stations.

Section 7. That Chapter 17.60 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.60.038 to read as follows:

17.60.038. Sewer use surcharge - Surcharge formula. At the approximate end of each month, quarter, or semiannually, as determined by the director, the director shall make a computation of the sewer use surcharge for each property discharging industrial wastes or other high strength sewage, using the following formula:

$SC = [\ Rp(Pi\text{-}Pn) + R_s\,(Si\text{-}Sn) + R_x\,(Xi\text{-}Xn)\ ] \times 8.34 \times V$

Where SC = Surcharge, $

Rp = Unit BOD cost (or COD cost when used in lieu of BOD) of treating normal sewage, $/lb

Pi = BOD or COD in the industrial waste, p.p.m.

Pn = BOD or COD in normal sewage, p.p.m.

R_s = Unit suspended solids cost of treating normal sewage, $/lb

Si = Suspended solids in the industrial waste, p.p.m.

Sn = Suspended solids in normal sewage, p.p.m.

R_x = Unit cost of treating any additional substance in the industrial waste, $/lb

Xi = Substance requiring additional treatment in the industrial waste, p.p.m.

Xn = Substance requiring additional treatment in normal sewage, p.p.m.

8.34 = lb/million gallon-mg/1

V = Wastewater volume, million gallon

Section 8. That Section 17.60.060 of the Lincoln Municipal Code be and it hereby is amended to read as follows:

17.60.060. Sewage meters. Subject to the approval of the director, any user of the Lincoln Sanitary Sewer System may, at the user's option and expense, install one or more sewage meters or other sewage-measuring device to measure all sewage discharged into such system; and, if required by the director, any user of such system shall install one or more such meters or devices at the user's expense. The director shall not require the installation of sewage meters or other sewage-measuring devices if the property is not discharging industrial wastes or other high strength sewage, unless special or unusual conditions merit the making of such a requirement. The director shall have the right to remove, repair, and reinstall any such permitted or required meter or device at the user's expense.

Section 9. That Section 17.60.080 of the Lincoln Municipal Code be and it hereby is amended to read as follows:

17.60.080. Water turned off for nonpayment of sewer use charges. If any sewer use charge be not paid within a period of thirty days after the same becomes due, the water may be turned off and the service not renewed until all arrearages are paid, including the further sum of five dollars for turning off the water and five dollars for turning the water back on, the same being the estimated cost to the city of such labor.

Section 10. That Section 17.60.100 of the Lincoln Municipal Code be and it hereby is amended to read as follows:

17.60.100. Defective meters. In any case where it has been impossible to read any water or sewage meter or other measuring device, or if the director reasonably determines that any such meter or device has failed to measure accurately during the billing period in question, the sewer use charges shall be computed upon an estimated water or sewage flow for the period and the meter or device repaired and tested at the expense of the sewer user.

Section 11. That Section 17.60.110 of the Lincoln Municipal Code be and it hereby is amended to read as follows:

17.60.110. Billing adjustments. Where by reason of special or unusual conditions, the water consumption fails to reflect properly the quantity of sewage actually discharged from a property into the Lincoln Sanitary Sewer System, the director shall have the power to adjust such billings.

Section 12. That Section 17.60.130 of the Lincoln Municipal Code be and it hereby is amended to read as follows:

17.60.130. Billings to commence; limiting of sewer use charges. The basic sewer use charges imposed by this chapter shall be billed with all billings based upon meter readings made on and after January 24, 1972. The sewer use surcharges imposed by this chapter shall be billed commencing on and after January 24, 1972, such billings to be made monthly, quarterly, or semiannually, as determined by the director.

Provided that ownership remains the same, the total annual sewer use charge for any given property shall, to the extent the flows and strengths of sewage remain the same as during the 12-month period immediately preceding the first meter reading made for such property on or after January 24, 1972 (which period shall be designated as the "base period"), be limited to (a) a maximum annual increase for the first 12-month period after the base period of 100% of such sewer use charges for the base period, (b) a maximum annual increase for the second 12-month period after the base period of 200% of such sewer use charges for the base period, and (c) a maximum annual increase for the third 12-month period after the base period of 300% of such sewer use charges for the base period, and (d) thereafter there shall be no limitation on the total sewer use charges as otherwise provided for herein; and any excess of such flows and strengths above those of the base period in any of the foregoing three of the 12-month periods shall be subject to the total sewer use charges on such excess for such periods, as otherwise provided for herein.

Section 13. That Chapter 17.60 of the Lincoln Municipal Code be and it hereby is amended by adding a new section to be numbered Section 17.60.140 to read as follows:

17.60.140. Hearing board. The provisions of section 17.58.180 (hearing board) of this title shall apply to this chapter with like force and effect. Provided, however, that in the event of a dispute between any person and the city concerning the amount of any sewer use charge imposed by this chapter, the city may require such person to pay such disputed amount to the city pending final arbitration or adjudication of the matter, and if upon final determination it be found or ordered that the city repay such disputed amount or portion thereof, the city shall repay same with interest at the legal rate.

Section 14. That Sections 17.60.010, 17.60.030, 17.60.060, 17.60.080, 17.60.100, 17.60.110, and 17.60.130 of the Lincoln Municipal Code as hitherto existing and all other ordinances and parts of ordinances in conflict herewith be and they hereby are repealed.

Section 15. That this ordinance shall take effect and be in force from and after its passage and publication according to law.

Introduced by

Marie McAlee [signature]

Approved as to Form:

Richard R. Wood

City Attorney

ADOPTED

MAR 22 1971

BY CITY COUNCIL

APPROVED

MAR 30 1971

Sam Schwartz [signature]

MAYOR

APPENDIX F

REFERENCES

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1. "Design Report - Papillion Creek Water Pollution Control Plant", prepared for the City of Omaha, Nebraska, by Henningson, Durham, and Richardson, 1972.

2. "Post-Primary Treatment - Missouri River Plant, Omaha, Nebraska", prepared for the City of Omaha, Nebraska by Kirkham, Michael and Associates, 1972.

3. "Water Pollution Control Improvements - Council Bluffs Sewage Treatment Plant", prepared for the City of Council Bluffs, Iowa by Henningson, Durham and Richardson, 1970.

4. "Wastewater Collection and Treatment", prepared for the Omaha-Council Bluffs Metropolitan Area Planning Agency by Henningson, Durham & Richardson and Stanley Consultants, June, 1972.

5. "Omaha-Council Bluffs Wastewater Management Study - Phase I", prepared for Omaha District, Corps of Engineers, by Havens and Emerson, Ltd., October, 1974.

6. "Supplement III; Wastewater Treatment Plant No. 1", prepared for Bellevue, Nebraska, by Kirkham-Michael, March, 1974.

7. "Simulation of Water Quality in Streams and Canals, DOSAG-1", Texas Water Development Board, 1970.

8. "Missouri River Hydrology (Streamflow and Temperature)--Sioux City, Iowa to Rulo, Nebraska", prepared for the U.S. Atomic Energy Commission by Battelle, Pacific Northwest Laboratories, October, 1972.

9. "Alternative Plans for Abatement of Pollution from Combined Sewer Overflows, Omaha, Nebraska", prepared for Omaha District, Corps of Engineers, by Harza Engineering Company, October, 1974.

10. Comments/Observations of 9/25/74 field inspection of City of Omaha Wastewater Collection System by R.W. Krotz, Havens and Emerson, Ltd.

11. "Design Report, Diversion and Grit Removal Improvements, South Interceptor Sewer" prepared for the City of Omaha by Leo A. Daly Company, August, 1972.

12. "Water Treatment Plant Wastes Report", prepared for the City of Council Bluffs Water Works Board of Trustees by Henningson, Durham and Richardson, 1973.

13. "Study and Report, Wastewater Treatment Plant No. 1", prepared for Bellevue, Nebraska, by Kirkham and Michael, April, 1972.

14. "Source of Metals in New York City Wastewater" by L.A. Klein, M. Lang, N. Nash, and S.L. Kirschner, JWPCF, December, 1974.

15. "Summary of Total and Major Industrial Wastewater Flows - Feb. 1, 1971 through Jan. 31, 1973"; Public Utilities Department, Lincoln, Nebraska.

16. "Interim Report, Regional Water Supply, Metropolitan Omaha, Nebraska-Council Bluffs, Iowa", prepared for the Omaha District, Corps of Engineers by Henningson, Durham, and Richardson, October, 1974.

17. The Practice of Water Pollution Biology, by the U.S. Department of the Interior, Federal Water Pollution Control Administration, 1969.

18. "Nutrient Management in the Potomac Estuary", by Norbet A. Jaworski, Donald W. Lear, Jr., and Orterio Villa, Jr., The American Society of Limnology & Oceanography, Inc., Vol. 1, 1972.

19. "Natural Carbon Sources, Rates of Replenishment, and Algal Growth" by Stephen D. Morton, Russell Sernau and Philip H. Derse, The American Society of Limnology & Oceanography, Inc., Vol. 1, 1972.